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Agfacolor

Dr. HEINZ BERGER

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Agfacolor

by

Dr. HEINZ BERGER

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A. No. 13877

Second edition

With an original enlargement on Agfacolor paper as frontispiece, 28 four-color plates, and 57 illustrations mostly in color

Translated from the German

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Preface to the first German edition

When, in 1936, the Agfacolor Reversal Film made its appearance on the market, the first step was taken towards developing color photography into a permanent conception as represented to-day by AGFACOLOR. This achievement was not a mere matter of a few months. Throughout many years, in the face of adverse circumstances, Agfacolor photography progressed to a state of development which makes possible its present release to the general public. Agfacolor photography excels itself by the simplicity of its application to the entire field of classical photography, as no other system of color photography can hope to achieve. Thus it implements black-and-white photography.

The present book was written to illustrate above contention. It touches upon other color-photographic processes only in as much as is absolutely necessary for a proper understanding of its contents.

Over a period of more than ten years I enjoyed the privilege of being able to assist in the progressive development of the Agfacolor process, first at the Wolfen Agfa film factory, and subsequently at the Agfa Photo works in Leverkusen. The book is the result of these experiences. It aims at giving as clear and comprehensive a picture of the practical side of Agfacolor photography as is possible. The task would not be complete, however, unless treatment was accorded also to the theoretical and historical aspects of this interesting and new field of photography. Accordingly, the book has been divided into two parts, the first of which, comprising sections A to C, is devoted mainly to theory, whereas the remainder of the work dealts exclusively with matters of practice.

It has been my endeavour to treat each part as an entirely separate entity, complete in itself both as regards matter and content, so that comprehension of the second part need not entail reading the first. But, for the sake of clarity, reiteration of certain statements could not be avoided.

The Agfacolor book presents the technical position as it stood at 1st March, 1950. In view of the fact that Agfacolor photography is in its early stages as yet, it may be assumed that the process itself, as well as its elaboration will progress further still, about which subsequent editions may need to report.

In conclusion I wish to express my grateful thanks to Dr. H. Hörmann for his technical assistance, to the publishers Messrs. W. Girardet of Wuppertal, and especially to Dr. V. Loeck, my sincere appreciation for the care with which they have arranged and produced this book.

Dr. Heinz Berger

Leverkusen-Bayerwerk, Agfa Photo works.
March the first, 1950.

Preface to the Second Edition

The widespread interest shown to Agfacolor Photography by every sector of the photographic world has left its imprint upon this little guidebook; a comparatively short lapse of time has made its second edition necessary. This presented the opportunity to incorporate all the further experience gained and advances made in the mean time; for a new field of endeavour such as color photography does not remain tagnant; and research keeps pace with its ever-increasing range of application. Thus, two new chapters have been devoted to the theory and practice of masking which is of special importance in color photography. Also, more space than hitherto has been given to Agfacolor Reversal Film, since this type of film, too, is now supplied in all sizes by Leverkusen; besides, processing by the professional user of reversal cut-films has been made possible. In connection with these additions, the number of diagrams has been increased to 59, and that of illustrations to 28. All the details concerning application and processing have been reviewed and brought up to date, so that the book now represents the state of progress reached at the end of 1954.

It is hoped that this second edition, too, will make its contribution towards a more profound understanding of color photography and advance still further its general application.

The author's sincere thanks are due to Dr. W. Behrendt, Dr. E. Hellmig, and Dr. H. W. Tromnau for their valuable assistance and suggestions, and again to the publishers, Messrs. W. Girardet, Wuppertal, and especially Dr. V. Loeck, for their ready accommodation of all wishes concerning the lay-out of this book.

Dr. Heinz Berger

Leverkusen-Bayerwerk, 18th January 1955

Agfa Aktiengesellschaft für Photofabrikation

Preface to the First English edition of this book

The introduction of Agfacolor to English speaking countries has made it essential to publish an English version of this book.

In this English edition it has been possible to include all new information and it can be considered as completely up to date.

Dr. Heinz Berger

Leverkusen-Bayerwerk, 27th June 1951
Agfa-Photofabrik

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Theoretical Part

H. Berger

Original enlargement on Agfacolor Paper

A. Historical and Theoretical

There is little enough to distinguish an undeveloped Agfacolor negative film from any ordinary roll-film: the normal celluloid film base has the common dyed gelatine anti-halation layer on the back, and what appears to be the usual sensitive gelatine emulsion on the front. Much the same is true of Agfacolor paper: the back has the usual Agfa imprint, and if the emulsion side is darker in color than that of bromide papers, the fact may pass almost without notice. To the naked eye, then, there is nothing to indicate the wealth of accumulated knowledge, research and technology that has been put into the Agfacolor process, or to suggest the wealth of color which appears in the developed images of both types of raw material. Nor is there anything which gives a real idea of the number of years that has been needed to produce a color process using the ordinary and everyday operations of monochrome photography.

Although it was known in the eighth century that "Horn Silver" — an impure mineral form of silver chloride — darkened when left standing, the first person to prove that this darkening was caused by light was the German doctor SCHULZE, in 1727. And even then, *Schulze*
although DAVY actually projected images with a solar microscope on *Davy*
to sensitised paper in 1802, he remained unable to fix the images he could produce, so that the year 1839 — in which DAGUERRE and *Daguerre*
FOX TALBOT almost simultaneously published details of two quite *Talbot*
different practical photographic processes — really ranks as the year which saw the birth of photography. Even at that time there were attempts to color by hand the monochrome images of the daguerreotype, so as to imitate painted miniatures, but since the images of DAGUERRE's process could not be copied easily, it was the negative- *Negative-positive process*
positive process of FOX TALBOT which eventually became universally used.

The original process here used thin paper, treated first with potassium iodide and then with silver nitrate, which formed in the

paper itself a sensitive layer of silver iodide. This paper was exposed in the camera, developed to a negative and fixed out. It was then printed on a similar piece of sensitised paper, and the result was a positive print, which was also developed and fixed. One of the primary difficulties of the process was that all the irregularities of the paper supporting the negative image appeared in the print, and it was thus a great step forward when the Frenchman LE GRAY (1850) and the Englishman ARCHER (1851) devised means of using glass plates to support the negative image. These workers produced suspensions of finely divided silver iodide in collodion (nitro-cellulose dissolved in organic solvents) and were thus able to coat glass with silver iodide emulsions. (The term emulsion, though universally used is a misnomer, the silver salt is really rather in a state of suspension than emulsified).

Le Gray
Archer
Collodion emulsion

Although collodion emulsions solved the problem of a transparent support for the image, they had the drawback that they had to be exposed while still wet, so that it was impossible to make them in bulk and put them into stock. Gelatine had been tried as a substitute for collodion without success for quite a number of years, but in 1871 Dr. MADDOX found out the correct way to use it as a vehicle for suspending silver iodide in fine particles, and photographic "dry" plates today are still made by using his basic principles. Since gelatine dry plates could be stored after they had been made, and exposed, developed and fixed when wanted, large scale manufacture of negative material became possible, and stocks could be kept without difficulty.

Maddox
„dry" plates

All present-day photographic processes, whether they use silver chloride, bromide, iodide, or a mixture of two or more silver halides — or even if the gelatine layer is partly or wholly replaced by synthetic materials — are based on these original "dry plate" principles, and color films themselves still use thin layers of gelatine containing suspended silver halide particles.

Glass negative material has all the advantages of dimensional stability and transparency, and the corresponding drawbacks of weight and fragility. The achievement of light, unbreakable, and reasonably stable transparent bases was first due to the Rev. H. GOODWIN of America, who made and used celluloid sheets for coating with sensitive emulsion in 1887. These products were the first photographic "films" ever made, and the combination of the "dry" gelatine emulsion and the flexible transparent base was the ultimate cause of the

Goodwin
„Film"

spread of photography into every field of civilised life. The various "roll", "flat", "cinema" and "miniature" films were gradually developed from the original material, and without materials of this kind the cinema and modern radiography would both be non-existent.

The combination of celluloid base and gelatine emulsion was not only essential to monochrome photography; it has also proved to be the basis of color photography. But the developments in this direction have been connected with the silver halide emulsion and less with the material used for the base.

To photograph in colors, it is essential to have emulsions which are sensitive to light of all colors, since otherwise certain colors may not be "seen" by the negative material at all. But the usual plain silver halide compounds (such as those used by DAGUERRE, FOX TALBOT and MADDOX) dot not have this quality: they are sensitive only to blue light, and record light of all other colors as black. When these emulsions are used to photograph colored objects, even pure bright colors which contain no blue will appear as black in the print. Thus, while a red or orange object should be reproduced as light grey, it is black in the print, and one may see in photographs taken forty years and more ago that the red lips of the person shown are nearly black instead of light grey.

If it had proved impossible to remedy this fault, practical color photography could never have been possible, but in 1873, H. W. VOGEL discovered that if certain types of synthetic organic dyestuffs were added to the silver halide emulsion, the sensitivity was extended to colors other than blue. The greatest progress in the years following SCHULZE had been made principally by Frenchmen and Englishmen; now again it was a German who made this most important discovery in what was then still a very young science. It is generally termed "optical sensitising" and without sensitising of this kind modern panchromatic emulsions, quite apart from color films, would not exist. The general principles of optical sensitising have been used in monochrome photography in innumerable variations for different purposes, most of which are connected with the problem of reproducing colors in their correct grey tones in a print. This particular problem, however, has no connection with color photography, for here we require colors to be reproduced as colors and not as various tones of neutral grey, and it becomes important to determine just how colors can be reproduced as such in the first place.

H. W. Vogel

Optical sensitising

Light and colors

All colors are visual sensations, which means that they only appear when light falls on the retina of the human eye. This light may come from natural light-sources, such as the sun, or from artificial sources, like our electric lamps or the older gas-mantles, but on examination all these kinds of "white" light prove to be heterogeneous and not homogeneous in nature. If white light is passed through a prism, for instance, it does not emerge as white light on the fair side: instead it is separated out into a whole series of colors, the main ones being blue, blue-green, green, yellow and red. This series forms the "spectrum", as it is called, and is illustrated in Plate I, fig. 1.

Spectrum

It must be concluded from this experiment that white light is formed by combining all the colors of the spectrum, and it is worthy of note that the three component colors blue, green and red are each nearly one-third of the total spectrum, while blue-green and yellow only occupy relatively very small bands between them. (See. Plate I, fig. 2.) Scientifically, it is convenient to consider colors in terms of the wavelengths of light known to be associated with them. Thus, blue light has wavelengths varying from 400 to 470 millimicrons (a millimicron is a millionth of a millimetre, and usually abbreviated to mμ), while green has wavelengths between 500 and 570 mμ and red between 600 and 700mμ. The entire spectrum thus consists of light with wavelengths between 400 and 700 mμ. In the prism, the shorter wavelenghts are bent or "refracted" more than the longer ones, with the result that the white light is separated out into a band of light with different wavelengths.

The color of the objects we see around us springs from the fact that their surfaces, on being lit with white light, absorb certain wavelengths of the light and reflect back other wavelengths toward our eyes, and it is these reflected wavelengths which determine the "color" of the objects as they appear to us. Thus, red objects absorb blue and green light, and reflect red light, while green objects reflect green light and absorb red and blue. Black objects, clearly, will absorb equally all wavelengths which reach them, so that there is nothing left to reflect back towards our eyes. The extraordinarily wide gamut of colors existing in nature is thus due to the peculiarities of surface reflection possessed by the objects of nature around us.

It is evident that the ultimate problem of color photography is to record and reproduce all these combinations of reflected light, and the problem became a matter of concern to scientific people as soon

as monochrome photography became practicable. As early as 1855, the physicist CLERK MAXWELL showed that all the colors of nature could imitated by mixing together suitable intensities of three colored light only — red, green and blue. This suggests that all natural colors must themselves consist of mixtures of the three "primary" colors red, green and blue, so that if separate records could be made photographically of the proportions of the three in the original subject, it should be possible to synthesise the original colors from the three records. Although this possibility is inherent in the earlier work on color by YOUNG and HELMHOLTZ, CLERK MAXWELL actually put it into practice, and demonstrated before a scientific audience what must have been the first color photograph ever made. He used the "additive" process described below, and the result seems not to have satisfied him. In 1939, however, his original positives were found, and a color print made from them. When one recalls that all this was years before the discovery of optical sensitising, the result must be considered surprisingly satisfactory.

Clerk Maxwell

Young Helmholtz

A few years later (1862), DUCOS DU HAURON wrote his classical paper called "Solution physique du problème de la réproduction des couleurs pour la photographie". It has been said of DU HAURON that his papers on color photography anticipate every development in the field that has appeared up to the present, but this work was not accepted by the Académie des Sciences, and remained unpublished until 1897. In the paper, he describes how three photographs must be made through red, green and blue filters, which will then record the corresponding color components of the subject. These separation negatives, as they are universally called, are then printed to ordinary transparent positives, which are placed in three projection lanterns so arranged that the three images on the screen coincide. Then the original blue filter is placed on the lantern with the positive from the blue-filter negative, the original green and red filters being placed on the lantern with the positives from the green and red-filter negatives respectively. The composite image on the screen will then appear in its original colors. (Fig. 3.) This method also produces full black — where no light at all falls — and full white — where all three colored lights reach the screen in their full intensity. Since the general principle here is one of adding colored lights together, the method is decribed as an "additive" color process. (The method described was the one used also by CLARK MAXWELL.)

Ducos du Hauron

Separation negatives

Additive color process

The colors produced by this type of process are very strong and pure, since purity of hue in the color filters is quite easily obtained,

but great practical difficulties beset additive processes in general. In the simplest case, three projection lanterns are required, but if the records are placed side by side on a single film — as in such well-known processes as the Lumière Autochrome Plate, the original Agfacolor Mosaic Plate, and Dufaycolor Film — the projector must have at least three times the usual intensity of lamp in order to make up for the very great loss of light in the filters. It is also not possible to make prints on an opaque base such as paper by an additive process.

Mosaic Plate

This last difficulty derives from the fact that when making a color print on paper one cannot mix colored lights, but must depend on pigments or dyes of some kind, which absorb some portion of the white light falling on them, and reflect a particular color in the direction of the eye. In a color print, therefore, the color must be introduced by absorbing some of the white light which would otherwise reach the eye from the white paper of the base.

Pigment colors

It may be as well to remark here that pigments, dyes and other colored materials cannot appear in their usual colors unless light of that wavelength reaches them to be reflected. Thus, since sunlight contains all wavelengths of light, all colors are seen in it: in half-watt lamp-light, where there is much less blue and much more red than in sunlight, all blues become duller and darker, while all reds become lighter and more brilliant. In light from discharge lamps, such as the sodium or mercury lamps used to light streets at night, some colors do not appear at all, for light of this kind consists of short ranges of wavelengths, and does not show a continuous spectrum when put through a prism.

When using pigments, one cannot therefore print primary hues of red, green and blue on top of one another: the result is black and not white, for each pigment absorbs two-thirds of the spectrum and reflects only one third. Nor does one get blue-green by printing blue and green on top of one another, while yellow does not result by doing the same thing with red an green.

When making color prints on an opaque base like white paper, therefore, it is necessary to use a different set of three primary colors. This is done by choosing a set of primaries which each transmit two of the three additive primaries red, green and blue, so that each new primary transmits two-thirds of the spectrum and only absorbs one-third. We may regard these primaries as being produced by *subtracting* from white light one of the original additive primaries: thus,

Subtractive primaries

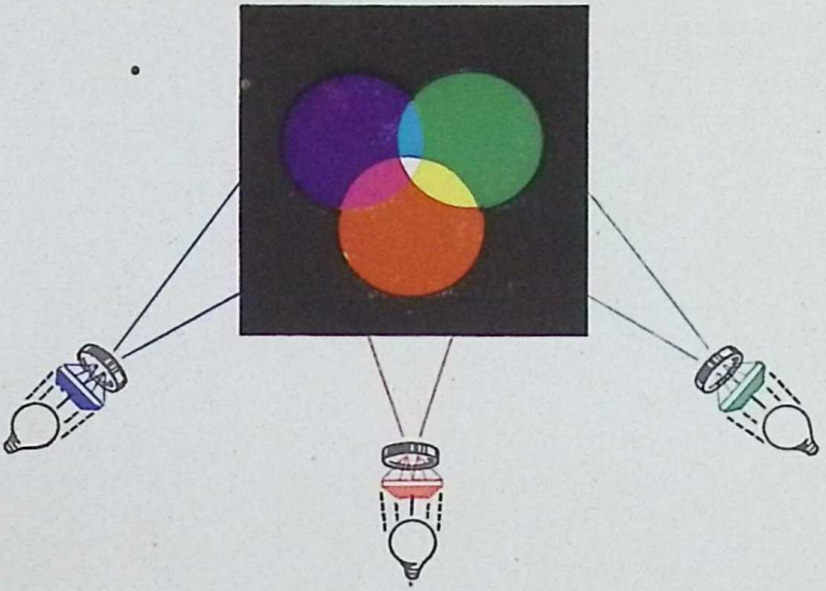


Fig. 3

The principles of additive color mixture

The three primary colors are projected as colored light on to the white screen. The overlapping of pairs of colors produces the color mixtures blue-green, magenta and yellow, the latter two being "blue-red" and "red-green". All three colored lights together give white, while no light is naturally black.

The basic disadvantage of the additive process is that one must either use three projectors, or else use a single projector with at least three times the light intensity that is satisfactory for projecting monochrome images. Further, prints on an opaque base cannot be made by the additive method.

subtraction of red light from white produces blue-green; subtraction of green light from white leaves blue-red or magenta, and subtraction of blue light from white gives red-green or yellow.

Because of the method of obtaining them, these new primaries are usually referred to as "subtractive primaries", and they are often — and very correctly — called Minus Red, Minus Green and Minus Blue instead of blue-green, magenta and yellow respectively. Equally, since each subtractive primary may be added to the corresponding additive primary to give white light (e. g. yellow plus blue lights form white and so on) the additive and subtractive primaries taken in pairs are complementary colors to one another.

Color mixtures may be made with these subtractive primaries just as readily as with the additive primaries, but color mixture in this case is produced by subtraction from white and not by the addition of colored lights to give white light. If no subtractive primary color is present between the white paper base of a color photograph and the eye, then we still see the white of the paper; if all three subtractive primary colors are present in superimposition, then no light is allowed to pass, and the eye perceives black. (See fig. 4.) If *blue*-green and magenta (i. e. *blue*-red) images are superimposed, the former subtracts red and the latter green, so that the only light which can reach the eye is *blue*, while superimposed images of blue-*green* and yellow (i. e. red-*green)* produce *green*, and those of yellow and magenta give red; that is, in each case the common color of both subtractive colors.

It is important to realise that this subtractive method of producing colored images on an opaque base does not need any greater volume of light than that of an ordinary black and white print, while a transparency in color by the same process requires only the same projection lamp intensity as a monochrome lantern slide. For the ordinary purposes of color photography, and in particular where color prints are involved, it is thus far more practicable to use the subtractive method than the additive method, and in actual fact not only every color photograph on paper, but also every printed color illustration (whether letterpress printing or lithographic prints are concerned) are produced from the three subtractive primaries yellow, magenta and blue-green. (The printers often call their primaries yellow, red and blue, but their red is really magenta and their blue really blue-green.)

From the point of view of exposure, subtractive color processes — with the exception of Agfacolor Negative film — start in just the same way as do the additive color processes: three separation negatives are made through red, green and blue filters and positives are made from them. But from here on, the process differs, for instead of using a black and white positive as does the additive process and projecting through colored filters, no filter is used on the projection lantern, and the monochrome positive images are changed into colored images in the three subtractive primaries, in such a way that the color density at any point on them is proportional to the density of the original monochrome silver image. This implies that where the silver was very dense, a very strongly

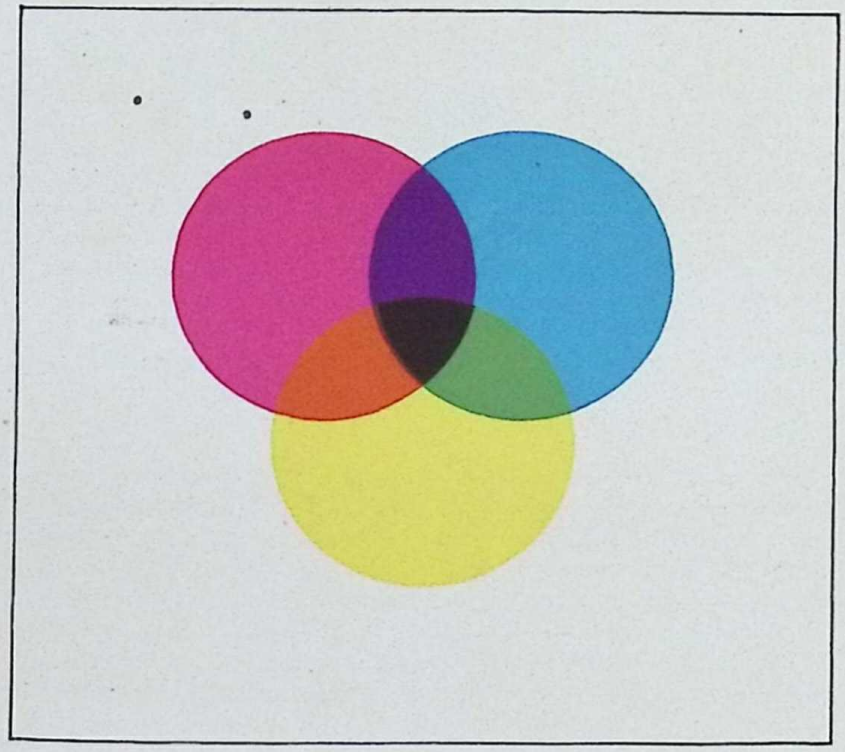


Fig. 4
The principles of subtractive color mixture
The three subtractive primary colors yellow (red-green), magenta (blue-red) and cyan (blue-green) each absorb one-third of the spectrum: when two are overprinted the resulting color mixture absorbs two-third of the spectrum, and the hues of the magenta overprinted on cyan (blue-green) gives blue, and yellow overprinted on cyan (blue-green) gives green. Where all three subtractive primaries are overprinted, all colors are subtracted from white, and black results, while where no color is printed, the original white of the paper appears

colored subtractive image must be produced, while any image-point which had no silver density must have no colored image whatever. As will be seen later, dyestuffs are normally used to produce these colored images, and the color of the dye must be carefully chosen to get the complementary color of the filters used to produce the separation negatives. Thus the positive from the blue filter negative is printed as a yellow (minus blue) dye image; that from the green filter negative as a magenta (minus green) dye image, and that from the red filter

negative as a blue-green (minus red) image. The rule here is thus that the positive image must be converted into a dye image having the complementary color to that of the filter used to expose the negative.

The problem of converting silver images into dye images, as may be imagined, is not a very simple one. In general the method used is to produce a silver image and a dye image simultaneously, so that the positive is both colored and monochrome at the same time. To remove the silver, which would otherwise obscure the dye image on projection, a bleaching bath such as FARMER'S reducer may be employed, after which a dye image alone remains. But when this has been done, the three positives are placed in superimposition in a single projector, and the result on the screen is just as satisfactory as in the earlier case of the additive process (Fig. 5).

The general difference between the two types of processes can be ilustrated in the following way. In the additive process, the positive from the red filter negative is projected through a red filter on to the screen. Where the positive is thin, a good deal of red light reaches the screen, and where it is dense very little red light reaches the screen — if any at all. Exactly the same effect is produced in the subtractive process by a blue-green positive dye image: the blue-green dye absorbs red, so that where it is thin, a fair quantity of red light reaches the screen, but where it is dense, little or no red light does so.

The exact manner in which the subtractive process operates can be even better shown by a series of diagrams. If, for example, a green plant with a red flower in a yellow pot is exposed against a black and white background and a blue sky, the negatives made through the usual red, green and blue filters appear as shown in fig. 6a. In the blue filter negative, the sky will be dense, the plant, flower and pot having practically no density; in the green filter negative the green of the plant and the yellow pot will be dense and the other colors very thin. In the red filter negative the flower and the pot (for yellow reflects red as well as green) will be dense and the rest very thin. By making positives from these negatives the densities are reversed, as seen in fig. 6b, and then each image is converted into the corresponding dye image. The "blue" positive is made yellow (minus blue), the "green" positive magenta (minus green) and the "red" positive blue-green (minus red). In the "blue" positive after dyeing, therefore the sky area of the image will be transparent, and not have any yellow image while the other areas of the image e. g. flower and

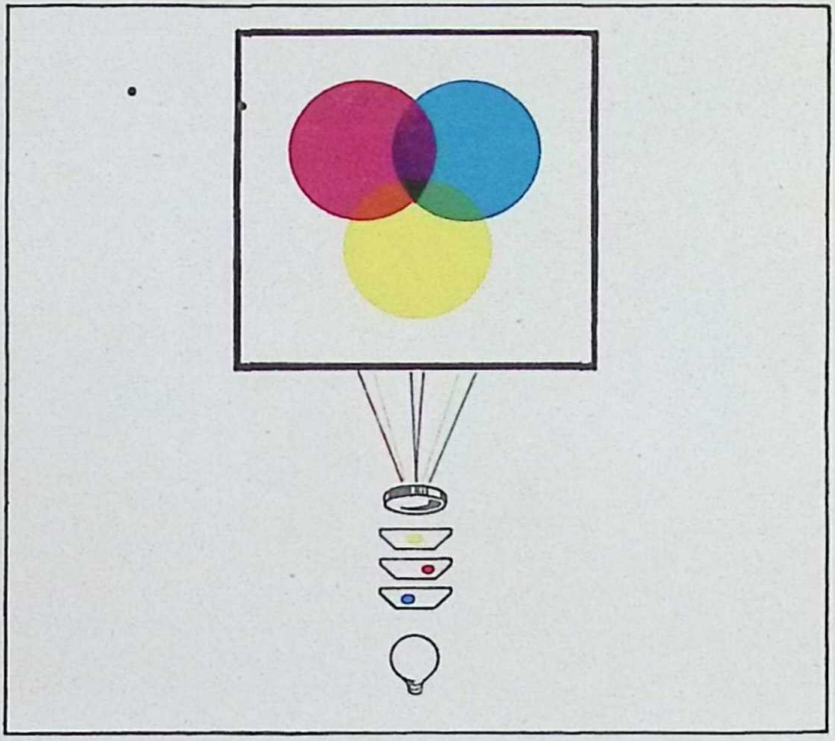


Fig. 5
The same colors as in fig. 4 may be used for projecting positive transparencies in color. Only one lantern is required, and thus no more light intensity than an ordinary monochrome lantern slide. (This is an advantage over the additive process.)

plant (except the whites) will have a yellow color density. In general, in fact, each colored positive will have a color density at all points where objects *not* of the same color as the camera filter are recorded: the "green" positive will have magenta color density only in the sky and the flower, but not in the plant, for this was originally green — or "minus magenta". In the same way, the cyan image of the "red" positive appears at all points which were not originally red. On superimposing the three separation positives in register, the result is to recreate the original colors of the subject photographed (fig. 6 c).

As has been said, only the subtractive process can be used to produce color prints on paper: to carry this into practice one requires

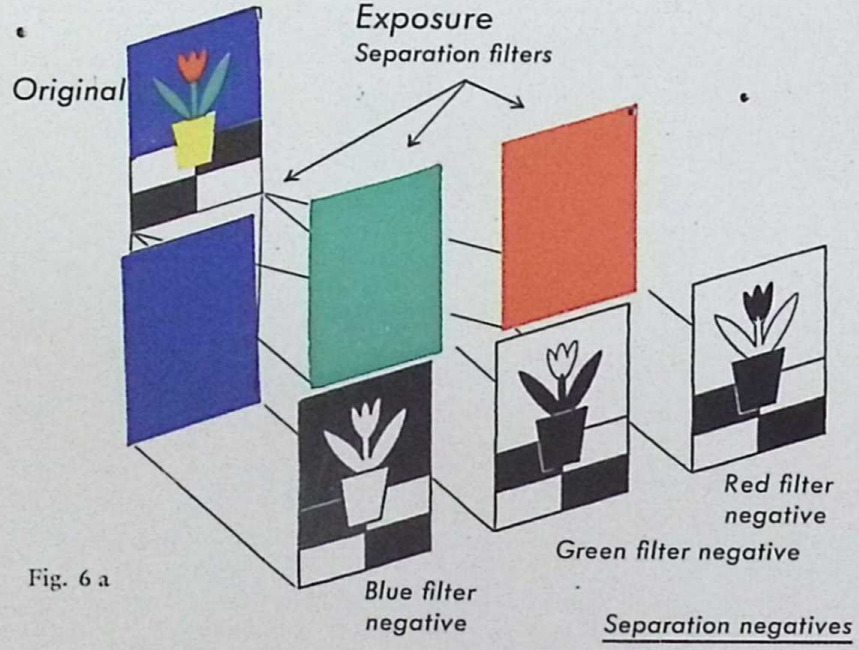


Fig. 6 a

Fig. 6
The subtractive color process

Fig. 6 a
Exposure of the separation negatives

Three separation negatives are exposed through red, green and blue primary filters. Objects reflecting light of the same color as the filter will record as dense images in these negatives: the images of objects reflecting light of other colors will either be very thin or completely transparent. Thus, all blues are dense in the blue filter negative; greens and yellows are dense in the green filter negative and so on. White is dense in all three negatives, while black is naturally transparent in each of them.

Fig. 6 b ⟶
Prints of colour positives

The separation negatives are printed to black and white positives, and then given dye images proportionate in density to the silver image. Each positive has an image of color complementary to that of the filters used on the camera for its negtive — the "blue" positive is thus made yellow (minus blue), the "green" positive magenta ((minus green) and the "red" positive cyan (blue green) i. e. (minus red). By doing this, each positive bears a dye image at those points which were n o t originally the color of the camera filter. The silver positive image is then removed, so that only a dye image remains.

Fig. 6 c ⟶
Reproduction

The three dyed positives are superimposed in register, and reproduce the original colors of the scene photographed. (Magenta + yellow = red; yellow + cyan (blue green) = green; cyan (blue green) + magenta = blue). This principle may be used equally well for both transparent positives and for prints on paper.

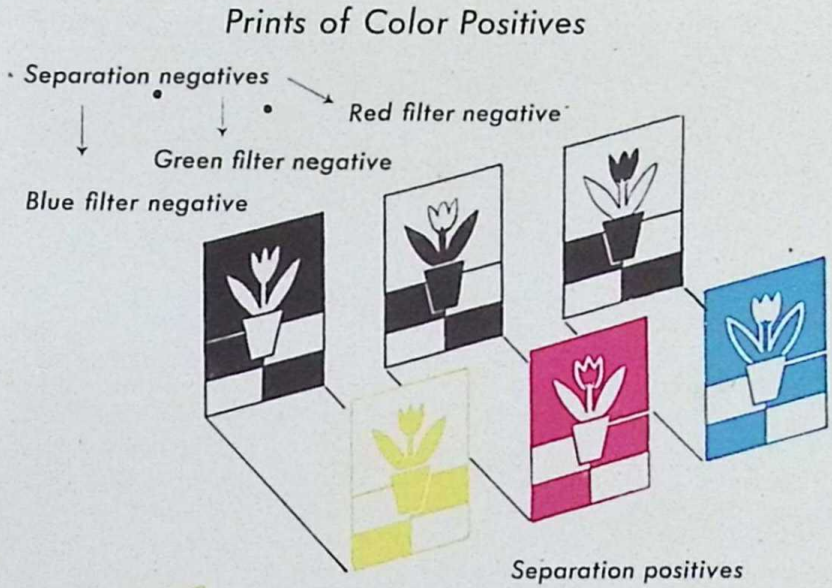

Prints of Color Positives
Separation negatives
Red filter negative
Green filter negative
Blue filter negative
Separation positives
in complementary colors to the camera filter

Fig. 6 b

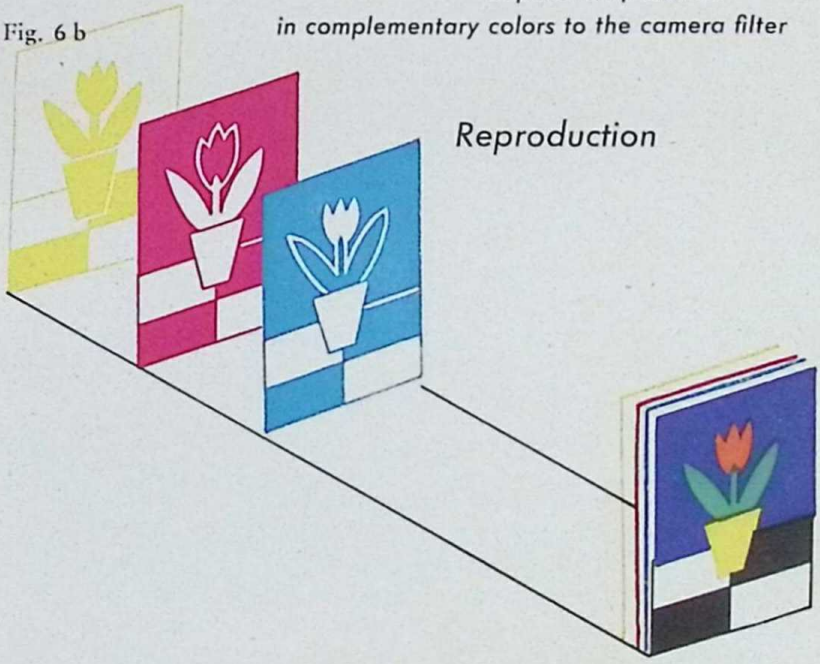

Reproduction

Fig. 6 c

a material for the camera which simultaneously records the subject in terms of red, green and blue primaries, and a positive material for printing which can turn the negative images into separation positive images in the subtractive primary colors yellow, magenta and blue-green. It is perfectly feasible, of course, to make separation negatives on panchromatic material through primary filters, but in this case there is the inconvenience that the separation positives must be on separate bases and then either superimposed on each other or else have their images transferred in register on to a final support. Advancing technique by photographic manufacturers, however, has now made it possible to produce negative materials consisting of three separate emulsions coated on top of one another, on a single celluloid base: it is thus now feasible to coat three emulsions to record the reds, greens and blues of the original subject one over the other, so that all three separation negatives can be exposed simultaneously. Since it is obviously impossible to use filters for this kind of material, the color-sensitivity of the three negative emulsions has to be arranged in such a way as to dispense with them. It has been noted above that silver halide emulsions are themselves sensitive only to the blue of the spectrum, so that the blue filter and panchromatic emulsion of the separation negative technique may be replaced by a plain blue-sensitive silver halide emulsion. For the green filter negative, a silver halide emulsion not only sensitive to blue but also sensitised for the green may be used; but because of the original silver halide, it will be sensitive both to blue and green. In a similar manner the red filter negative is produced by sensitising for red, so that this emulsion is blue and red sensitive. In order to counteract the blue-sensitivity in the latter two cases, it is only necessary to coat these two onto the celluloid base underneath the blue-sensitive layer, and to place a yellow filter layer under the latter. This filter layer absorbs all the blue light reaching it, so that the two emulsions below it are effectively capable of recording green and red light only.

Multi-layer film

A multi-layer film of this kind (sometimes called a monopack film) is therefore constructed as shown in fig. 7 a (opposite) and fig. 7 b (Plate II). On the back of the celluloid base is the usual layer of dyed gelatine which serves to prevent halation effects, and on the front of the base is coated first of all the red-sensitive emulsion. Over this is then coated the green-sensitive emulsion, followed by the yellow filter layer which removes the effects of blue-sensitivity in the green and red sensitive layers. On top of all these is coated the blue-sensitive layer, followed by a layer of plain gelatine to stop

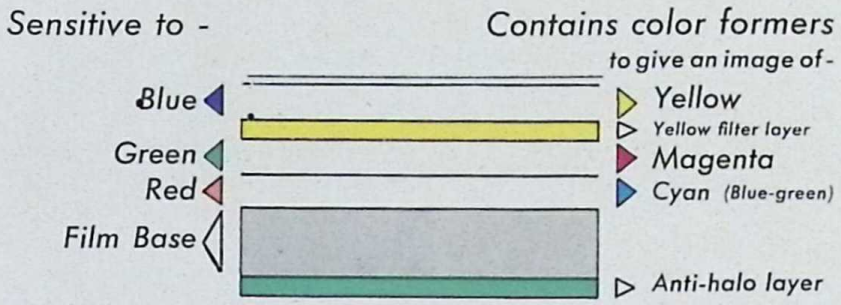


Fig. 7 a
Cross-section of Agfacolor film (Schematic)

mechanical damage by abrasion, but which has no photographic function. The resulting multi-layer film is now capable of recording separation images in terms of red, green and blue.

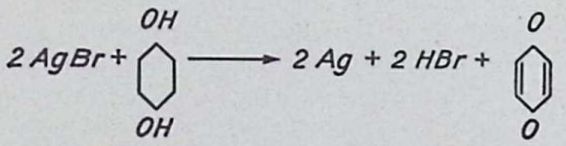
If a film of this kind is exposed in the camera and then developed in metol-hydroquinone in the usual way, the result — to the naked eye — will be very similar in general to the negatives exposed on panchromatic negative films such as Agfa Isopan F. But on examination, it may be seen that three separate images are present in the different emulsions which, when superimposed, produce a series of tone-correct densities in the various colors such as are formed in the single emulsion of the panchromatic film. Although, however, our multi-layer film is successful in producing a combined set of color separation records, there is no manner in which one of them can be distinguished from the other two when it comes to printing to a positive — unless the three records are separated and printed separately. This last is an operation which has been proposed in many patents, and has even from time to time been attempted commercially, but without any real success: the difficulties involved are so great and the cost of handling so high.

For a practical multilayer film color process, therefore, it is essential to find a practical and simple method of distinguishing between the three negative images in printing. The first hint of a practical solution to this problem appeared in 1909, when RUDOLF FISCHER — following work by WITT (1882), SACHS (1899) and HOMOLKA (1907) — discovered the process now known as "color *Rudolf Fischer*

Color development

development". As all practical photographers know, there are a large number of chemical agents other than metol, hydroquinone, rodinal and so on which can be used to develop photographic emulsions after exposure. Among these are paraphenylenediamine and its derivatives, which are frequently used in photographic practice as fine-grain developing agents, and it is with this particular class of chemicals that *Fischer* worked.

All developing agents are chemically changed when they reduce the exposed silver halide grain of an emulsion during development, and hydroquinone (the usual material chosen to demonstrate this) is changed as it develops into quinone. This is an oxidation process corresponding to the reduction of the silver halide to metallic silver.

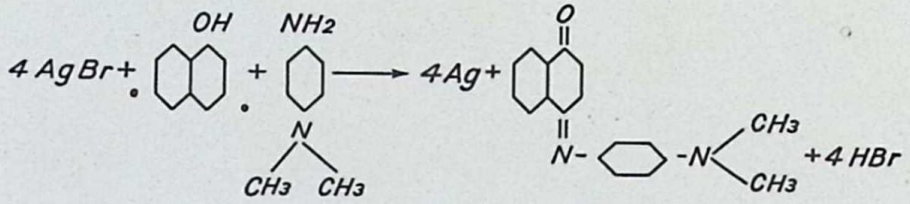


Silver bromide — Hydroquinone — Silver — Hydrobromic acid — Quinone

A similar reaction to this takes place when paraphenylenediamine is used for development, for the silver halide is reduced to metallic silver and the developing agent oxidised. But as the paraphenylenediamine is oxidised, it becomes strongly reactive, and — given a suitable material for reaction — can form new chemical compounds. FISCHER's disvovery was that if certain chemicals, such as α-naphthol (cyan), pyrazolonderivatives (magenta) or the acetoacetic esters (yellow), were provided, the reactive oxidation compound of paraphenylenediamine would "couple" with them, and that the new compound formed was an insoluble dyestuff. The result of development under these conditions was that both a silver image and a dye image appeared in the emulsion simultaneously.

Chromogenic development

The reagents which produce this effect are now universally known as "color couplers" or "color formers", an FISCHER named the process "chromogenic development", which is now usually contracted to "color development". FISCHER, moreover, found that images of any desired color could be obtained by dissolving the color former, or a mixture of different color formers, in the developer with para-



Silver bromide | α Naphthol | Dimethyl-paraphenylene-diamine | Silver | Blue-green dyestuff | Hydro-bromic-acid

phenylenediamine, so that one simple process of development sufficed to produce both a silver image and an image of insoluble dye.

The neatness and elegance of this process lies in the fact that the dye image is only formed at the points in the emulsion where silver halide is reduced to metal, so that it fulfils all the needs of a subtractive color process: where no silver develops, no dye is formed, and the density of color of the dye image is proportionate to the density of the silver image. This happens because the oxidised developing agent is formed at the point where silver is developed from its halide, and the reactive material is immediately in contact with the color-forming chemical, and does not have to diffuse through the emulsion before it reacts. The dye image is thus a perfectly sharp one, and not a diffused one. The developed image does not show any definite color when examined immediately after development, since the dye is obscured by the usual black silver image, but after removing the silver by a suitable bleaching bath and fixing, the dye image alone remains in the gelatine of the film or paper used. FISCHER marketed a special Chromal paper for use with his process, on which any desired single image color could be produced at will.

It is thus clear that color development offers, in principle, a means of differentiating the images of the three emulsions in a multi-layer film or paper, and thus of producing a color photograph by the subtractive process. It would only, for instance, be necessary to develop the bottom, red-sensitive, layer in a color developer giving cyan images, the central green-sensitive layer in one giving magenta images, and the top blue-sensitive layer in one giving yellow images for a correct color image to result. Unfortunately, this is much simpler said than done: it is quite possible to dissolve the three color formers in a single developing solution, but there is possible way

of making each of them affect one single emulsion layer only. The only result would be that each layer developed dye images in all three colors.

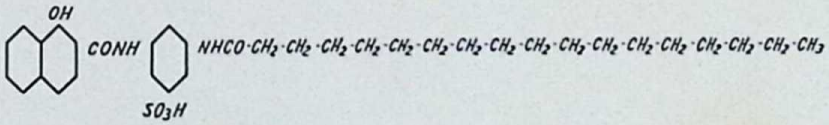
It is this special difficulty — that of individually developing the three layers of a multi-layer film — which has held up the production of a successful color process for so many years after FISCHER had successfully shown the basis on which such a process could be built. He himself recognised the difficulties perfectly well, and even suggested that by using insoluble color formers it would be possible to include these in the emulsions rather than the developer solution, and thus dispose of the problem. In 1911 he tried this method in the laboratory, but found that although the insoluble color formers certainly stayed in their proper emulsions, they failed to couple properly with the reactive oxidation product of the developing agent. It seemed, in fact, that unless the color formers were in solution at the time of development, they could not react adequately. But the general principle of a color process based on these facts stayed before the eyes of technical people as a tantalising vision: there was nothing technically impossible in making multi-layer films; there was no difficulty in sensitising the three emulsions correctly, and it was possible to produce the necessary subtractive dye-images by color development. In spite of all this, however, it was a quarter of a century before the scientific and technical problems involved in making color formers which would remain in their correct layers — and react there — were solved.

Agfa had been actively interested in color photography even before the time of FISCHER: in 1916 they marketed the Agfacolor Screen Plate as their first product in this field. This was an additive material giving a transparency, and in 1932 the Agfacolor Lenticulated Film appeared, which was also an additive material but used quite a different general principle to produce the colors. The difficulties of obtaining sufficient light were evident in these two materials, as with all additive processes, and efforts were redoubled on the general problem of a material using a subtractive process. The general line of thought now adopted was that color formers should be included in the emulsions when they were coated to form a multi-layer film, and that they should not have to be added to the developer solution: the intention here was that it should be possible to develop the film in one single solution and to obtain in one operation three dye-images in the component emulsion layers.

As has been said above, this was the line of thought initiated by *Fischer,* though he had not been able to find a practical method of carrying it out.

The real problem here is that color formers are essentially soluble by nature, since otherwise they cannot be used in a solution of developer. This quality of solubility is essential, moreover, since without it the color formers cannot be uniformly mixed with the emulsion before coating and be uniformly distributed throughout its bulk, while a certain degree of solubility is also essential if the color formers are to react at all with the products of development. On the other hand, soluble materials in an emulsion will certainly tend to dissolve out when the developing solution is applied, and if they diffuse from one layer to another in this manner they will certainly react in the wrong emulsion and thus cause incorrect colors to be developed there. While it is thus essential that the formers have some degree of solubility, it is equally essential that once the emulsions have been coated they should be effectively insoluble.

These two technical qualities appear to be entirely incompatible with one another, but the problem was eventually solved by the team of workers under G. WILMANNS at the Agfa Research Laboratories. The principle used so successfully by them was to make the color formers of large molecular size, though still soluble: the large molecules would mix uniformly with the gelatine emulsion when the latter was fluid, but once the gelatine had set, their large size prevented them from moving in the relatively small spaces between the sponge-like network of the gelatine jelly. As a result, the color formers are soluble, but fast to diffusion. The structure of the molecules used for this purpose may be seen from the formula below for a blue-green color former.



To use a simplified illustration, any tendency on the part of these color formers to move through the gelatine jelly is arrested in the same way as a tree-trunk is when one tries to carry it through a dense wood or forest. This technical solution to the ultimate problem by Agfa has at last made it possible to carry the process projected by *Fischer* into everyday practice.

The Agfacolor reversal film, which came on the market in 1936, was the first product to embody these results: the color formers were included in the three emulsions during manufacture in the manner already outlined. The bottom red-sensitive emulsion contained blue-green color former, the centre green-sensitive emulsion magenta color former, and the top blue-sensitive layer yellow color former. A single developer was used which developed simultaneously the three dye images in the different emulsions, and no diffusion of color formers occured.

The difficulties of producing suitable emulsions for films of this type, however, are very considerable. Any emulsion for such a purpose must contain not only the color sensitiser and the color former, but also other chemicals to stabilise the emulsion, to make it keep satisfactorily after manufacture, and to improve the general behaviour of the silver halide grains in various other ways. But none of these additions to the emulsion must react with any other addition, and none of them must affect the qualities of the emulsion adversely in any way. On the mechanical side, too, film is coated in lengths of several hundred yards at a time, and although the three emulsions — and also the yellow filter layer — are each much under a thousandth of an inch in thickness, this thickness must be accurate to narrow limits. Any irregularity of emulsion thickness will cause variations in the color produced after exposure. The purely technical achievement of producing a material of this type in practically complete darkness is thus a very considerable one, quite apart from the chemical aspects of the process.

A multi-layer film using the subtractive color process was also marketed in 1935 by Kodak, which was similarly based on the color development process. Here, however, the color formers were not included in the emulsions during coating, and a series of complex operations to produce the colors in the appropriate layers was arranged to be carried out by the makers in an automatic machine. A film of this kind can, clearly, not be developed and finished in the simple manner that is possible with Agfacolor, and very high technical standards are necessary for consistent results to be obtained even by mechanical means.

In this first subtractive Agfacolor film, the result was a transparent positive in color produced by the reversal process (Fig. 8). This last is a photographic process by means of which the original film exposed in the camera is made to show a positive instead of the usual negative image, and involves the series of operations described below.

MONOCHROME REVERSAL FILM

1. *First Development to a Negative Image*
2. *Removal of Reduced Silver*
3. *Second Exposure to Diffused Light*
4. *Monochrome Development to a Positive*
5. *Fixing*

Agfacolor REVERSAL FILM

1. *Development to Monochrome Negative*
2. *Second Exposure to Diffused Light*
3. *Color-coupling Development of Residual Silver Bromide*
4. *Bleaching of the Silver Reduced during First and Second Development*
5. *Fixing*

Fig. 8

Both kinds of processes have the same number of processing steps. The only difference consists in the necessity to remove immediately the silver reduced during first development in monochrome reversal processing, while in color reversal development the entire image-producing silver is not bleached and dissolved out until both first and color development have been completed.

The ordinary negative image produced by camera exposure is first developed with a normal photographic developer of suitable type. This produces color separation records in terms of red, green and blue in the three appropriate emulsions of the film. (Fig. 9a.) The unexposed and undeveloped silver bromide remaining in the film, however, is still light-sensitive, and it can form the basis of a positive image. This is done — whether a monochrome or color film is in question — by first dissolving the developed silver image out of the film, exposing the residual silver bromide to light, and then developing to a positive image. The color development process used with Agfacolor reversal film is practically identical with that used for ordinary monochrome reversal film: after developing the monochrome negative image the film is merely exposed to light and placed in the color developer. Here the positive silver image appears, and at the same time the three yellow, magenta and cyan dye images appear simultaneously in the correct emulsion layers: this is only possible because of the diffusion-fast color formers used in manufacture. Both the silver negative and the silver positive image are then bleached out in a simple bath and the film fixed, when a positive image in dyes only appears. It will be seen that the whole process is essentially simple, and quite uncomplicated. (Fig. 9b.)

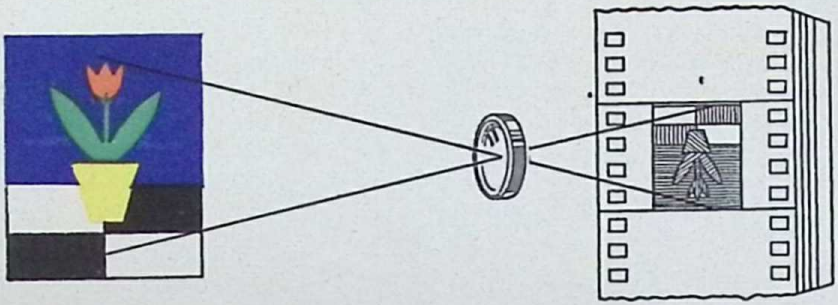


Fig. 9 a
Formation of the image in Agfacolor reversal film. Exposure in the camera produces a record on three emulsions of the red, green and blue components of the color of the original subject.

This simplicity in processing is a matter on which Agfa have always laid great stress: the ideal of a color film is that it should be capable of being developed and printed just as easily as monochrome material, while all the chemical and physical difficulties of the color process should be dealt with by the manufacturers. Admittedly the Agfacolor reversal films were usually sent back to the maker for processing, in order to ensure that consistent results were obtained on them, but from the time of their first appearance there was no technical or photographic reason why they should not have been developed and reversed to color positives by the user. In fact, Agfacolor Reversal Cut film has been processed by the user since 1953.

It is true that Agfacolor reversal film was rather limited in certain directions. It is well known that a reversal process in photography allows a much smaller exposure latitude from the correct value than a negative-positive process does, and since individual exposures could not be given individual processing treatment, the color reproduction was not always as good as the material was capable of giving Moreover, it is only possible with difficulty to make copies of the film or to produce paper prints from it. These limitations are largely offset by the fact that quick and simple processing methods produce a positive colored image readily, and it was this speed and simplicity which led Agfa first to introduce their new process in the form of a reversal film. Countless photographs on this kind of film in the form of miniature transparencies have, due to the luminosity of their colors, been the delight of riewers.

It will be useful here to mention a very important difference which exists between color prints on paper and colored transparencies. The latter are capable of showing a very much longer range

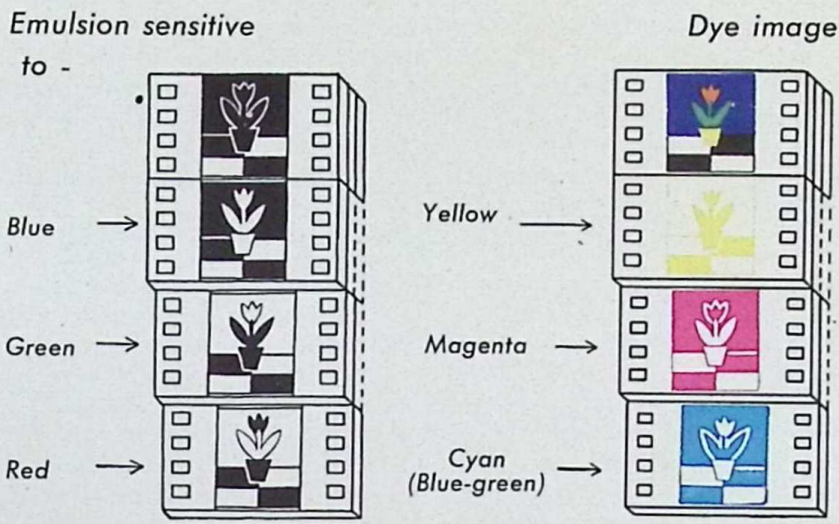


Fig. 9 b
Formation of colored images on Agfacolor reversal film
The negative image is first developed to a normal silver image (left) thus producing separation records in three emulsions (Fig. 6 a.) After a second exposure the residual silver bromide is developed to form a positive image in a color developer, thus producing the three positive dye-images in the correct emulsions. (Fig. 6 b.) The silver is then removed, and the dye-images alone remain, recreating the original colors of the subject. (Fig. 6 c)

of tones than the former, for while a transparency can give as high a tone range as 1 to 1000, a print on paper cannot give a longer range than 1 to 50 at the utmost. It thus follows that a transparent color positive always appears more brilliant to the eye than a color print can ever do.

Equally, transparencies — and this is true also of cinema films as well as still exposures — are shown exclusively in a darkened room, so that the colors of surrounding objects do not have any influence on the image. Because of this, a quite strong overall color tint will pass almost unnoticed, particularly if this general tint appears for some time, for the eye loses sensitivity to it. The tint is only really noticed where the scene is changed and a general tint of another color follows it.

Matters are very different where color prints on paper are concerned, since in this case the image is viewed exclusively in ordinary light and ordinary surroundings. As a result, the observer will — either consciously or unconsciously — compare the colors of

the print with those of its surrounding (a phenomenon referred to as "related color effect"), and his estimate of the colors in the print will be much more critical. Because of this, the general adjustment of color reproduction in a color print on paper is a much more critical matter than is the case with a transparency, and the difference between the two types of color photograph may be concidered by comparing, side by side, a color print and a color transparency.

The final ideal of Agfa has been repeatedly expressed as being a color material which may be printed to give any number of copies — whether transparencies or prints — from a given camera exposure. This ideal might be put into practice by using an original reversal material and then making copies on to a second reversal material, but it has been remarked above that the reversal process has its limitations, and while it is true that it is comparatively simple, it is not so simple as a simple process like negative development. Moreover, there are difficulties involved where prints are to be made on paper: the unexposed edges of the image always appear full black in a reversal copy, and unless special means were taken to get rid of them, paper prints in color would have black borders round them. To remove them would further complicate the process.*

Negative-positive process

There are other difficulties involved in the use of reversal methods for copying, so that if the ideal of many copies from one original exposure is to be carried into practice, it becomes simpler, more effective, and infinitely more logical to use a negative-positive process. There is nothing more theoretically satisfactory than to use the color formers in the ordinary way in a multi-layer film, to develop the camera exposure to a negative, and then to print or enlarge on to a suitable positive multi-layer material. The result of these two operations will then be a color print in the original colors of the subject. The negative-positive process does not, however, completely replace the reversal process in all cases: in some kinds of work — notably those of narrow-gauge film — only one copy is required, and the reversal process is economical and satisfactory.

As has so often happened with color processes, however, this theoretically simple method proves exceedingly difficult to put into practice, and a very great deal of intensive research has had to be

* At present, the only way of making prints from Agfacolor transparencies in monochrome is by way of an intermediate negative on panchromatic material followed by printing or enlarging on Lupex or Brovira paper. To use the simple way of making color prints by printing them on Agfacolor Negative film and then printing or enlarging on Agfacolor paper causes great loss of color saturation. Only by using a monochrome mask in adition to the color inter negative gives good results. (cf. Chapter H, 3, p . . .).

Fig. 10
Ideal subtractive primary colors
Each subtractive primary should ideally absorb only a single additive primary — its own complementary color — and should transmit or reflect completely the other two additive primary colors. Thus, yellow should only absorb blue, and should transmit red and green completely; magenta should absorb green and transmit blue and red, while cyan (blue green) should absorb red only and transmit blue and green.

done in order to determine the optimum conditions under which a color print can be made in this manner. One of the biggest difficulties is the fact that color prints must show, not only colors, but black and white as well, and the reproduction of a scale of grey tones as grey — i. e. without color tints intruding — is always a crucial test for any color reproduction process. The need here is that mixtures of the three subtractive primary dyes shall be capable of producing neutral greys, and since the demands of the color development process restrict a choice of dyestuffs to an exceedingly small range of possible choice, it is only possible to fulfil the neutral grey condition by accepting a certain loss of pure hue in the colors themselves.

Neutral grey condition

Subtractive primary colors should consist of dyes which only absorb those wavelengths of the visible spectrum between 400 and 700 mμ corresponding to their complementary color, and transmit or reflect all other wavelengths freely. The magenta dye should only absorb green, and not red and blue; the yellow dye should only absorb blue, and not green or red. (Fig. 10.) The practical dyes available for color photography do not, however, even approach this ideal: although they certainly have their maximum absorption in the region required, their absorptions do not cease abruptly as they ought to, and there is consequently a certain amount of overlapping of their absorption curves. (Fig. 11.) This results in a certain amount of darkening, called "desaturation", of the colors reproduced. On the other hand, the three emulsions must be capable of recording the primary colors red, green and blue in the correct proportions they

Overlapping absorption

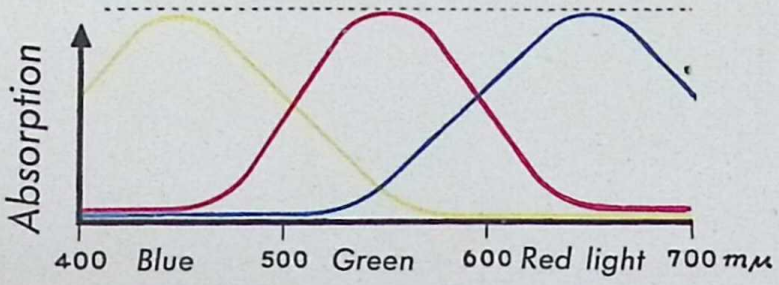


Fig. 11

Absorption curves of the dyes used in Agfacolor reversal film or Agfacolor positive film. (Schematic only)

The three dyes have absorption maxima in the required regions of the spectrum, but overlap in other regions. Colors are thus darkened or desaturated in the reproduction, but on the other hand the overlapping makes it possible for the total absorption throughout the spectrum to be even (as shown by the broken horizontal line) so that the visual effect of the three dyes in equal proportions is a neutral grey tone.

display in the original subject, and because of the qualities of the color sensitisers used in practice, some overlapping in color sensitivity occurs between the emulsions. (Fig. 12.) But if this sensitivity were used, and these subtractive dye primaries used, both for the negative and positive materials, the deficiencies of the dyes would doubly affect the color reproduction, and its perfection be lowered to a point where it would be quite unacceptable: the overlapping sensitivities of the emulsions would twice desaturate the colors and darken them unbearably.

Where different types of materials are used for negative and positive processes, however, it proves possible to deal with this last source of imperfection, although a great deal of research and experiment on the part of Agfa was required to find the most practically satisfactory solution to the problem. It has been stated above that in order to make color-recording complete, the three emulsions used for the negative film should have overlapping sensitivities of the three negative emulsions must cover the visible spectral range of hues in the primaries blue, green and red, as in fig. 12. But the dyes used for the negative image do not have to be seen visually, as was the case with reversal film, so that visual effects may be largely neglected so long as equal mixtures of the three dyes used appear to be "grey" so far as the emulsions of the positive material are concerned.

The positive material, on the other hand, does not need to be sensitive to all the spectrum, but only to the three colors used as

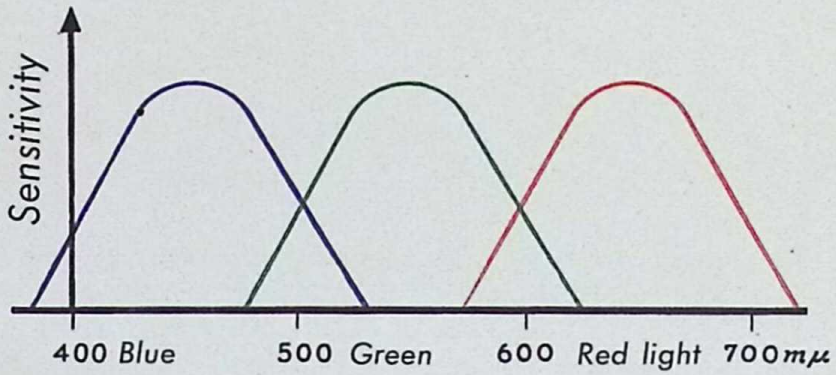


Fig. 12
Sensitising of Agfacolor Negative material (schematic)
The three emulsions are given sensitivity to the three primaries blue, green, red respectively. Because of the qualities of the color-sensitising dyes, this means that the sensitivity curves overlap to some extent.

primaries in the negative image. In fact, the color sensitivities of the three emulsions in the positive should be kept as narrow cutting and separate as possible in order to avoid any further desaturation of colors by overlapping sensitivity effects. This is possible in practice by choosing suitable sensitising dyes, and the very selective sensitivies of the three Agfacolor Positive emulsions are indicated in fig. 13.

Desaturation can clearly also be further avoided by arranging that the absorption curves of the dyes used to form the negative images do not overlap. (Fig. 14.) It is true that it is desirable to have the absorption maximum of the magenta dye in the centre of the visible spectrum at about 550 mμ wavelength, but there is no reason why yellow and blue-green dyes of the other two images should not have their absorption maxima well away from this point. If possible, in fact, the yellow dye should have its absorption maximum in the ultra-violet, and the blue-green dye its maximum in the infra-red. Since the human eye is insensitive both to ultra-violet and to infra-red, a color negative of this kind would look more or less plain magenta in color visually, since only the magenta dye would be truly visible. But if the three emulsions of the positive material were arranged to be sensitive to the ultra-violet, visible green and infra-red respectively, the negative image would be neutral grey so far as it was concerned. (Fig. 15.) The dye images of the positive material should, of course, have the same colors as those needed for the reversal color film described above, since precisely the same demands are made on them. (Fig. 11.)

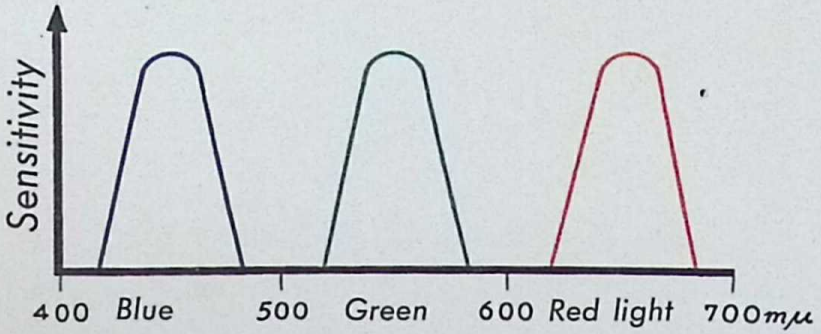


Fig. 13
Sensitising of Agfacolor Positive material (schematic)
By using very selective sensitivity curves, each emulsion of the positive has a sensitivity peak corresponding to the absorption peak of the dyes used in the negative images. (Cf. fig. 11 and 15)
This form of sensitising leaves gaps, into which the overlapping regions of the dyes used in the negative fall. Because of the unusually red sensitivity and the very selective sensitivities of the emulsions to colors, Agfacolor positive material is unsuitable for camera exposures.

Considerations such as those above have been embodied as far as was possible in the Agfacolor negative-positive process that is now available. The Agfacolor Negative film and the Agfacolor paper are both multilayer material of the kind shown in fig. 8, but they differ greatly in their sensitising and the colors of the primary dyes used. The developed Agfacolor negative does not show colors strictly complementary to those of the original subject, since the absorption maxima of the primaries are kept well apart, and because of this a "neutral grey" Agfacolor negative does not appear neutral grey to the eye, but has a general tint of brownish or reddish hue. But when printed on Agfacolor paper, this general tint disappears, and the general results of the process are a very true reproduction of colors coupled with the convenience of easily-made color prints on paper from a color negative.

By carrying all these points to their logical conclusion, the ideal that Agfa have always had in mind for a color process has at last been achieved: a process is available to everyone which is exceedingly simple for the user, while all the technical and scientific problems are dealt with in manufacture. The Agfacolor negative-positive process is, in fact, handled in practically the same way as ordinary monochrome photography. Camera exposure is just as usual, and the film is then placed in a color developer, its silver bleached, and all silver fixed out. The result is then a negative image with density

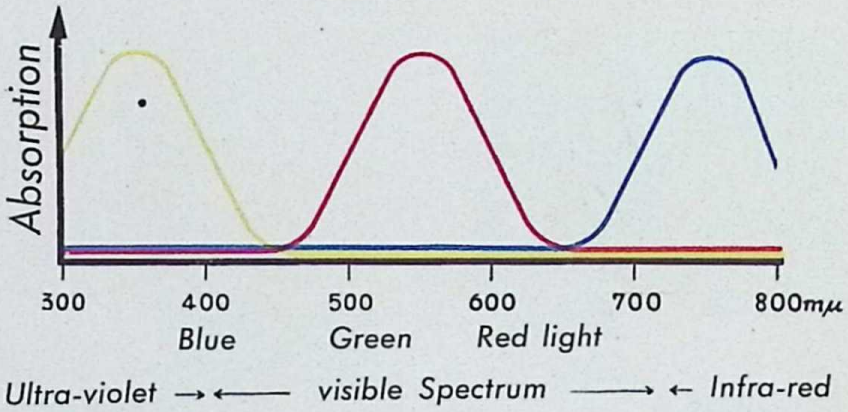


Fig. 14

Negative dyes chosen for selective absorption (schematic)

To avoid overlapping in the absorption curves of the primary dyes (Cf. fig. 11) the absorption maxima are separated as widely as possible. The yellow and blue-green dyes absorb chiefly in the ultra-violet and infra-red regions, in which the human eye is not sensitive, and the images will thus be practically colorless visually. Only the magenta dye is fully visible, and the negative will thus appear magenta in color when seen by the eye, although it is still "neutral grey" so far as the emulsion of the emulsion of the positive material is concerned. (Cf. fig. 15.)

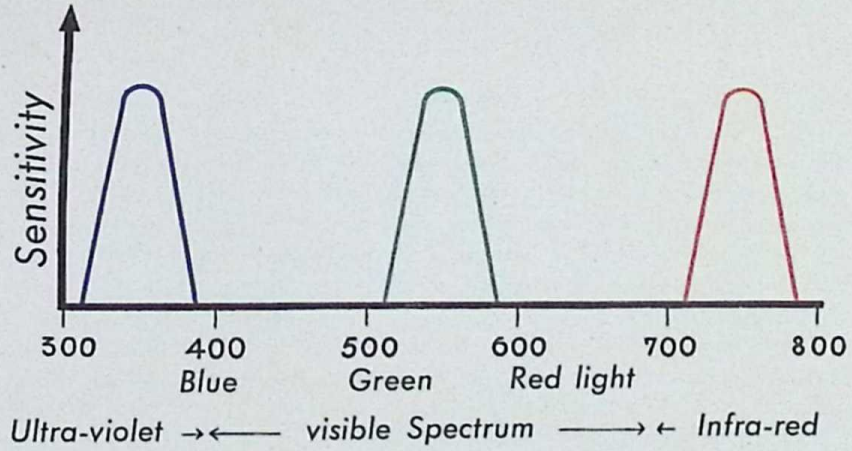


Fig. 15

Positive color material with wide-spaced selective layer sensitivities adjusted to the selective primary dyes used in fig. 14. A material sensitised in this way will "see" the color negative material of fig. 14 as grey, although the human eye considers it to be magenta only.

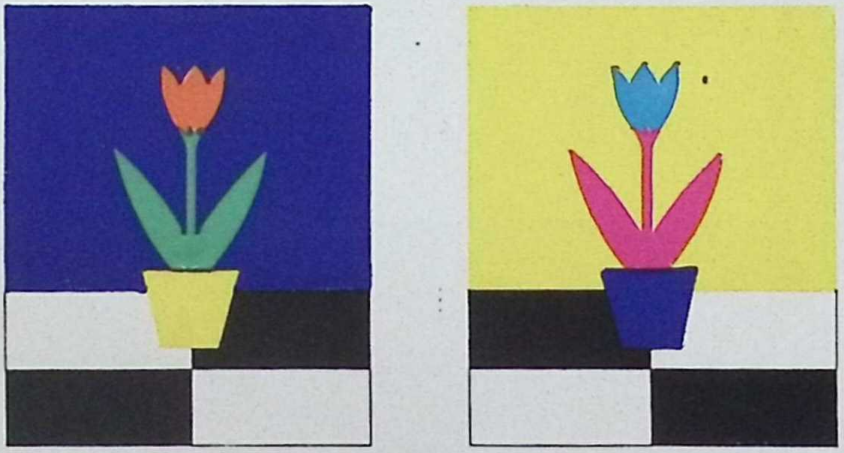


Fig. 16
Negative in complementary colors (schematic)
The colors of the original appear in the negative as their corresponding complementaries:
Blue becomes minus blue or yellow (red-green)
Green becomes minus green or magenta (red-blue) } and vice versa
Red becomes minus red or cyan (blue green).

the silver is bleached and the image fixed as usual. The result is a positive in natural colors, for not only do the blacks of the negative become white in the print and the whites black, but also the colors of the print are complementary to the colors of the negative. Since the negative colors are complementary to the colors of the original, inversely proportional to the subject brightnesses, while the original colors are converted into more or less their complementaries. (See above.)

In a negative in complementary colors, the blue sky becomes minus blue or yellow, all greens, such as foliage, minus green or magenta, and the red of lips minus red or cyan. (Fig. 16 and fig. 18, Plate II.) Neutral tones will, as explained above, have a non-neutral tint to the eye, though they will be fully neutral to the positive material. Such a negative is printed on Agfacolor Paper or Agfacolor Positive film, and the print then developed — just as the color negative was — in a color developer, after which the silver is bleached

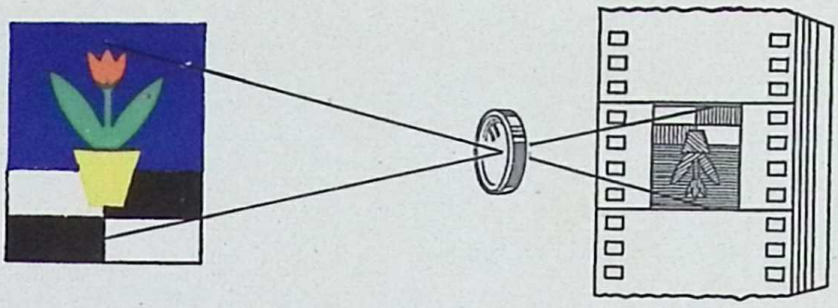


Fig. 17 a

Formation of Agfacolor negative in complementary colors. The color of the orginal is recorded as before in the camera on the three emulsions of the film sensitive to red, green and blue light.

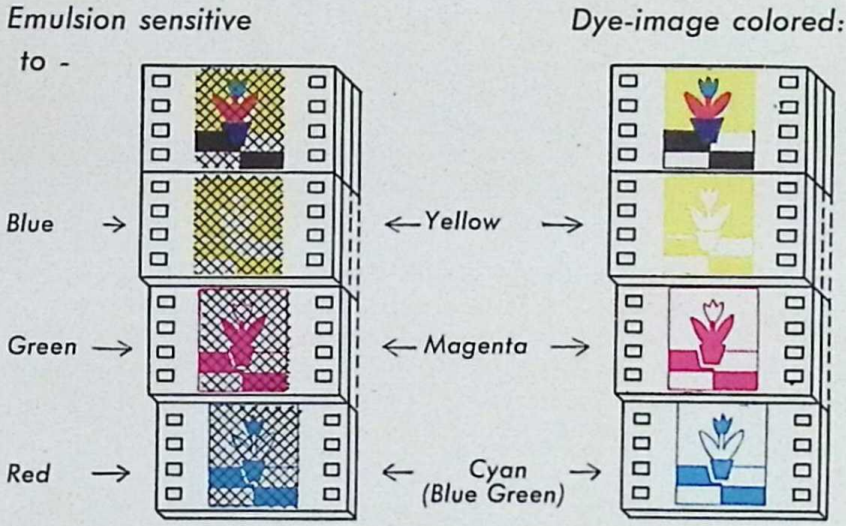


Fig. 17 b

Formation of Agfacolor negative in complementary colors

The color developer produces in the emulsions both a black silver image and a dye image in the complementary color to that of the emulsion sensitivity: the blue-sensitive layer develops yellow, the green-sensitive layer magenta, and the redsensitive layer cyan (blue green). (Left — the silver image is denoted by the crosshatching.) The metallic silver and the undeveloped silver bromide are then dissolved out (right), leaving the three separation negative images in dye only. These, superimposed, produce a negative image in complementary colors.

and the image fixed as usual. The result is a positive in natural colors, for not only do the blacks of the negative become white in the print and the whites black, but also the colors of the print are complementary to the colors the negative. Since the negative colors are complementary to the colors of the original, the original colors and those of the print are the same. (Fig. 19, Plate III.) The original blue sky becomes blue in the print, the blue-green lips of the negative become red in the positive, and the magenta foliage of the negative becomes green in the print. (Fig. 20 and 21.)

The production of the first negative-positive subtractive color process in the world was a great achievement on the part of Agfa, and the first raw materials were available late in 1939 — almost exactly a hundred years from the birth of photography. It had been decided earlier that since the film industry was already fully familiar with large-scale printing and processing to critical limits of tolerance, the Agfacolor Negative film should be first issued as 35-mm cinema film, and that 35-mm Agfacolor Positive film should be issued with it. Productions were made by UFA on these films in 1940 and the years following, and were very successful. Meanwhile, intensive work on the corresponding paper prints was kept up, and by 1942 Agfacolor Paper was available on a small scale for printing and enlarging from Agfacolor Negative film. A complete process for making paper prints in color from negatives in complementary colors was thus available for the first time, and it was decided to release the process generally immediately after hostilities ceased. For obvious reasons this was not possible, not only because the actual technical production of the raw materials for the process stopped for a time, but also because the working process and patents were made generally available to everyone. The result of this has been that various firms outside Germany have been attracted by the simplicity of the Agfacolor process and its high-quality results, and have taken it up.

To combat the various difficulties arising from these two sources, it was determined to produce Agfacolor material not only at the film factory in Wolfen, where it was originally made, but also at the Leverkusen factory. In spite of setbacks this plan was steadily worked to, and in January 1949, exactly 110 years after the first publications of *Daguerre* and *Fox Talbot,* and ten years after the first feature films in Agfacolor had appeared, the Agfacolor negative-positive process was made generally available to everyone. Agfacolor Negative film, Agfacolor Positive film and Agfacolor Paper are all now processed by the user when he wishes so to do, and the

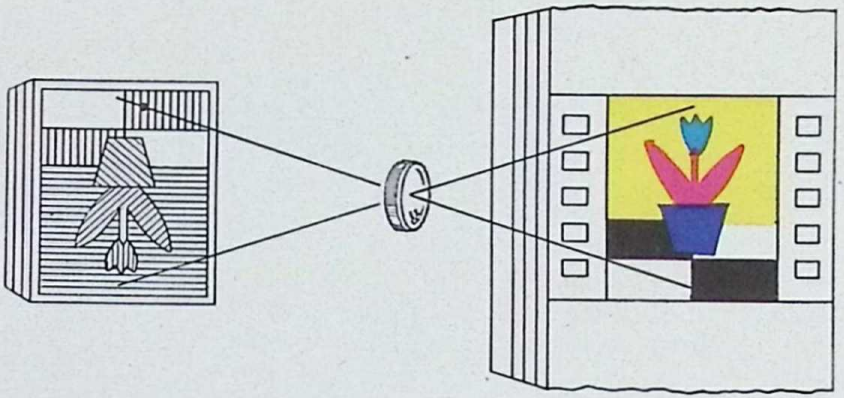


Fig. 20a

Formation of positive color image from negative in complementary colors.

Enlarging from the complementary-colored negative on Agfacolor paper (contact printing is, of course, identical in effect) causes a record of the dyes in the negative to be made in the three emulsion layers of the paper.

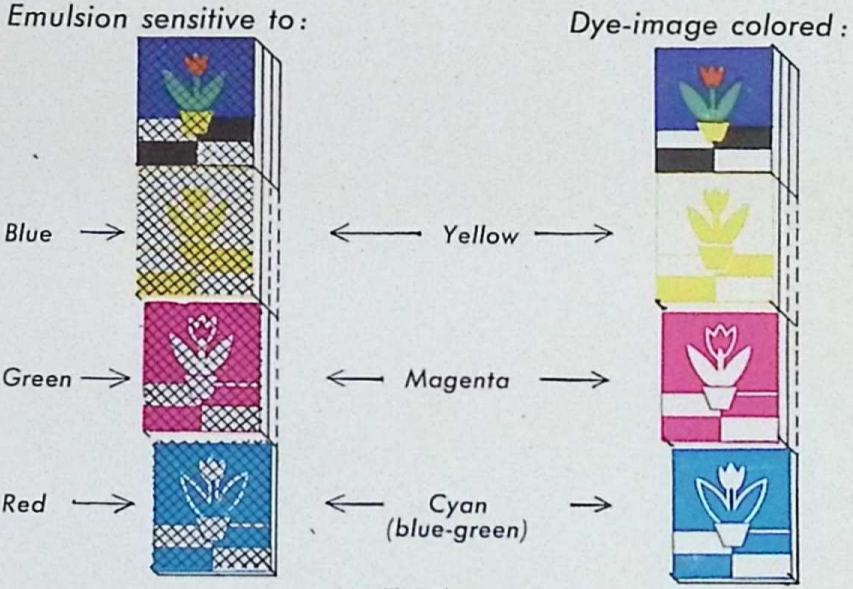


Fig. 20b

Formation of positive color image from negative in complementary colors.

Color development of the exposed paper produces silver images in three emulsion layers as well as a yellow dye image in the blue-sensitive layer, a magenta image, in the green-sensitive layer, and a cyan (blue green) image in the redsensitive layer. (The silver image is denoted by cross-hatching.) Removal of the silver image and undeveloped silver bromide (right) leaves the three dye-images alone in the layers, which produce a positive in the colors of the original subject when superimposed.

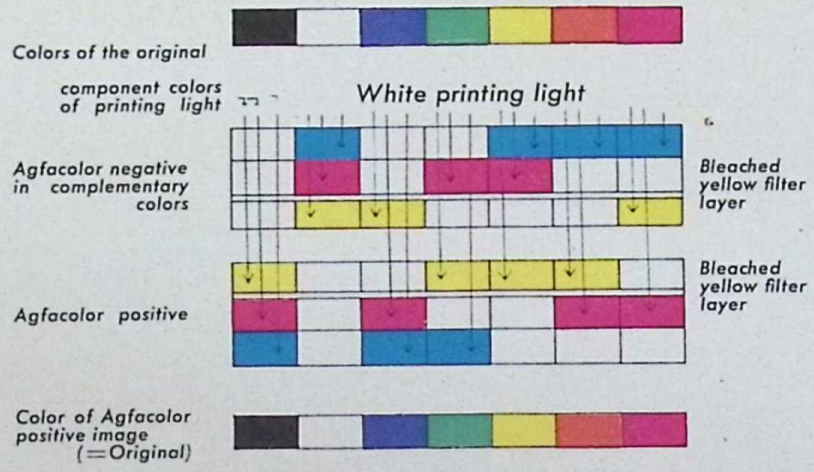

Colors of the original
component colors of printing light
White printing light
Agfacolor negative in complementary colors
Bleached yellow filter layer
Agfacolor positive
Bleached yellow filter layer
Color of Agfacolor positive image (=Original)

Fig. 21

Printing from Agfacolor Negative (schematic).

The white light used in printing contains all colors, some of which are absorbed as this light passes through the negative. The unabsorbed colors are then recorded in the appropriate emulsion layers of the Agfacolor positive material, and produce in them after color development a colored image. The colors of the positive are complementary to those of the negative, and therefore the same as those of the original subject.

Processing

MONOCHROME NEGATIVE	Agfacolor NEGATIVE	
1. Development 2. Fixing	1. Color development 2. Bleaching the silver image 3. Fixing	
MONOCHROME PRINTING PAPER	Agfacolor **PAPER** *Old Processing Method*	Agfacolor **PAPER** *New Processing Method*
1. Development 2. Stop bath 3. Fixing	1. Color development 2. Stop bath 3. Bleaching the silver image 4. Fixing	1. Color development 2. Bleach-fixing

Fig. 22

Comparison of processing operations required for monochrome photography and for Agfacolor negative-positive materials.

The two sets of processes are very similar, the primary difference being that the silver image of the Agfacolor material is bleached before fixing.

operations necessary for this purpose are only slightly different from those used in monochrome photography. (Cf. fig. 22.) A few additional operations — very few — are all that are necessary.

A truly workable method of color photography is thus at last available, covering all fields in which photography may be used, by which positive prints in color may be simple and readily produced for cinema films, transparencies or paper prints. This remarkable achievement opens up an enormous range of new interest and representational possibilities to the photographer, and both the color and the plastic effect of the process is excellent in effect. Not only, however, does the process open up possibilities for photography in the widest sense of the words: it places the whole of photographic work — amateur, professional, scientific or technical — and last but not least the cinema film at the cross-roads, and it is not yet possible to see which way the whole field will eventually develop.

B. Special points in the Agfacolor process

It has been pointed out more than once in the foregoing chapter that the ideal color process in the mind of Agfa has always been one which differs as little as possible in its technical operations from those of everyday monochrome photography. The usual difficulties of color-printing processes, so well known to those who have worked them, have therefore been disposed of as far as ever possible. The few differences remaining between monochrome technique and Agfacolor technique are dealt with below in order to round off and complete the theoretical aspect of the subject.

Both the Agfacolor reversal film, and the Agfacolor negative-positive materials, produce positive images in color. But while the reversal film must, by its nature, be given standardised processing treatment throughout, the negative-positive process allows a considerable amount of correction to be made to the color reproduction in the print or transparency. This comes about because of the separation of the process into negative and positive images, instead of a single reversal process being used.

Exposures on Agfacolor reversal film record the actual color effect ruling at the time of exposure: in the light of the setting sun, for instance, all colors are reddened, and the positive image has a general overall red tint. Such effects as this only occur visually when the quality of the light reaching our surroundings is suddenly changed — as from daylight to artificial light — and even in this case the eye so rapidly accustoms itself to the new light quality that either form of light is taken as being "white". As a result, color photographs may often give the impression of being generally tinted in some hue or other when the conditions of exposure are unknown: to our visual judgement "white" is always "white", although it may actually be quite strongly tinted by reflected light from strongly colored objects close by. At the same time such general tints as these (often described

by the cinema film cameramen as "flushes") may arise from bad storage conditions, slight variations in the film as manufactured, or even through unnoticed variations in the processing. Color-casts or "flushes" like this are, as has already been said, reproduced objectively by Agfacolor reversal film, and at best they can only be dealt with by giving the finished transparency a rather complicated chemical treatment in order to bleach out the flush tint and make the colors seem "correct" to the eye.* This kind of treatment, however, is not needed in the Agfacolor negative-positive process: color-casts certainly appear frequently in one or another color in the positive image, and for the same reasons as on reversal film, but they are removed in printing by suitably filtering the printing light instead of treating the finished print with chemicals. The other influences of storage, processing, and slight manufacturing variations can also produce color-casts on Agfacolor Negative and Agfacolor Paper, which necessarily appear in the print made from the complementary-colored negative, and it is not the least advantage of the negative-positive process that they are simply and accurately removed by a single filtering operation during printing or enlarging.

Color-casts

In order to appreciate the simplicity of this operation, it is important to understand how color-casts occur, and to do this it is first necessary to consider Agfacolor negative and positive images which show no color-cast. In an Agfacolor negative which is neutral in hue so far as the positive material is concerned, and thus has no color-cast of any kind, the absorption of the three primary dye images is equal from the point of view of positive sensitivity. (Fig. 23.) The correct reproduction of grey tones is one of the most difficult tasks in all color photography, but it is only when grey-tone reproduction is correct that other colors are accurately reproduced. The other conditions of color saturation and purity are naturally essentials as well.

Neutral Agfacolor material

Since grey tones may exist of wide brightness range, it is important that *all* grey tones appear as neutral grey in the color print. A series of grey tones may easily be formed in practice on Agfacolor material either by giving a series of regularly increasing exposures, or else by exposing through a step-wedge, which provides a regular series of neutral tones. The color density of the three emulsions may then be plotted graphically against the log. of the exposure (Fig. 23) and if

* Details of the chemical treatment of Agfacolor reversal transparencies for this purpose will be found in the Tables at the end of this book.

the material reproduces all grey tones as greys, then the three curves for the separate dye images will all coincide everywhere. This is true for Agfacolor Negative, Agfacolor Reversal Film and Agfacolor Paper as well, when no color-cast is present (Fig. 24). In the case of Reversal Film (Fig. 25) the color density curves run in a sense opposite to that of the negative film in fig. 23. The reason for this is that in a color reversal film the first step is the monochrome development of the exposed latent image. The tonal gradation of this developed image is very similar to that of the color negative. The second exposure acts on the silver bromide which had remained unaffected by the first development because it had received no light; it is reduced during color development. The darkest parts of the original, therefore, are not reproduced light as in a negative, but dark as in the original, and for the same reason the lightest portions will also appear light (cf. p. 21 and following)."

Color-cast of the first type

A color-cast occurs, however, when in either of the two materials the three curves, though remaining parallel, do not have the same color densities. This is termed a "color-cast of the first type", and the general effect is that three curves are separated horizontally instead of coinciding. The effect is shown for Agfacolor negatives in fig. 26, and for positives in fig. 27. To obtain a neutral grey tone, it is thus necessary to increase the color density values generally of the curves having the lower values until they coincide with the curve having the highest value. If this is done, then the three curves will once more conicide, and neutral grey tones will result. (Fig. 26b.) This would be best carried out by adding to the negative or positive image extra dye images, more or less dense, to make up the difference, but since this is not very simple in practice, the Agfacolor process uses instead a special set of Agfacolor printing filters which modify the color quality of the printing light. By this means, it is simple to correct the flush effects and thus obtain neutral greys*.

Agfacolor printing filters

The action of the printing filters may be described either in terms of the negative image or of the positive one, for its effects can be regarded from the two different points of view. In the case of the Agfacolor negative, the effect is that of adding to the negative an even tone of the filter color chosen. This is equivalent to moving the color density curve which has insufficient general density *vertically* upward, and by choosing the color density of the filter suitably the three curves may be made to coincide, as is indicated by the arrows in fig. 26. From the Agfacolor positive point of view, the action of

* Abouth the action and use of filters consult the chapter on „Exposure", Part F.

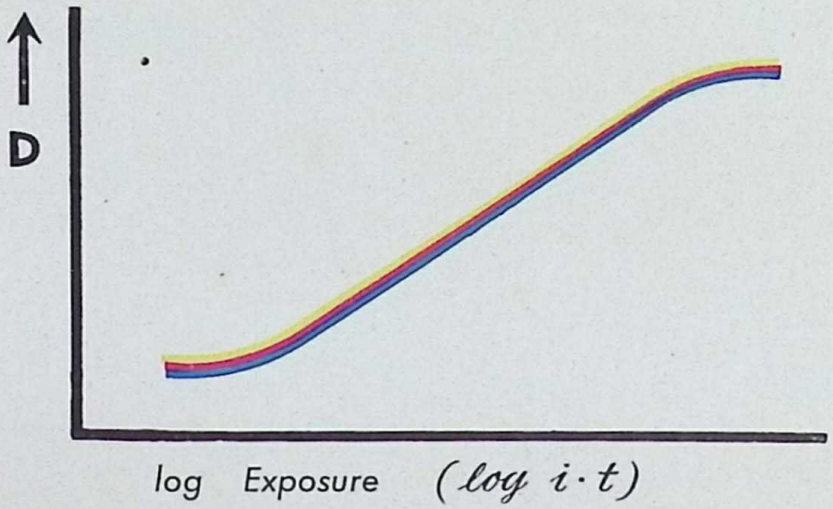


Fig. 23
Neutral Agfacolor negative (schematic).
In a negative which is neutral to the sensitivity of the positive material, the three color density curves for the dye-images of the negative coincide. (The color density curve is the color equivalent of the characteristic curve of monochrome photographic materials.) For reasons of clarity, the three curves are printed in contact with each other: in reality they should all be superimposed, where the image is neutral. (The same is true of figs. 25, 32 and 33.)

the filter is similar to that of a camera filter, in that it influences the relative exposures given to the three emulsion layers, and thus moves the color density curves *horizontally* parallel to one another, as indicated by the arrows in fig. 27. Clearly the presence of color-casts both in the negative and positive material may be simultaneously dealt with by using a suitable printing filter, its color and density being chosen to suit the particular negative and positive in use at the time.

The foregoing will indicate the reasons why Agfacolor printing filters must be available in the three subtractive primaries yellow, magenta and cyan, and why each filter color must be available in a considerable range of color densities. The depth of the various printing filters has been adjusted in such a way that if magenta, cyan and yellow filters of the same numerical value are superimposed, the effect in printing of the combination would be a neutral grey: the intensity of the printing light would be reduced, but its color would not be changed. The highest density of the printing filter in each

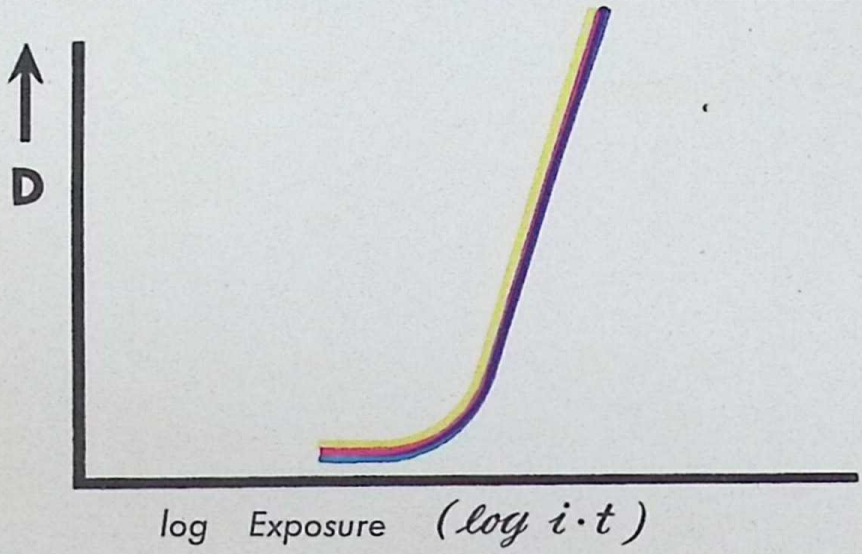


Fig. 24
Neutral Agfacolor positive (schematic).
In Agfacolor positive material which is neutral to the printing or enlarging light, the color density curves for yellow magenta and cyan (blue green) images coincide. The color density curves are equivalent to the characteristic curves of monochrome materials. (See note under fig. 27.)

color is marked as 100 units. The other filters of the series cover the difference between 100 units and nil in ten equal steps of 10 units each, so that color densities between 0 and 100 are covered in ten steps. An additional filter of 5 units is also provided, so that by adding it to any of the other filters the color density may be increased, in each of the three colors, by steps of 5 units. There are therefore eleven filters in each color, and 33 filters in all in the set of printing filters.

To simplify their recognition and use, each filter is marked with a six-figure code number denoting its color and density. The first two figures indicate yellow, the second two magenta and the last two cyan color, while the figures in each pair indicate the filter density itself. To keep the code number down to six figures, the highest density filters are coded as 99 instead of 100. On this coding, a yellow filter of 10 units is marked 10 00 00, a magenta filter of 50 units is marked 00 50 00, while a cyan filter of 99 (100) units is marked 00 00 99. The coding will be seen to eliminate all confusion, and is convenient where records are being kept. Since filters are frequently used in pairs, the coding is conveniently extended to

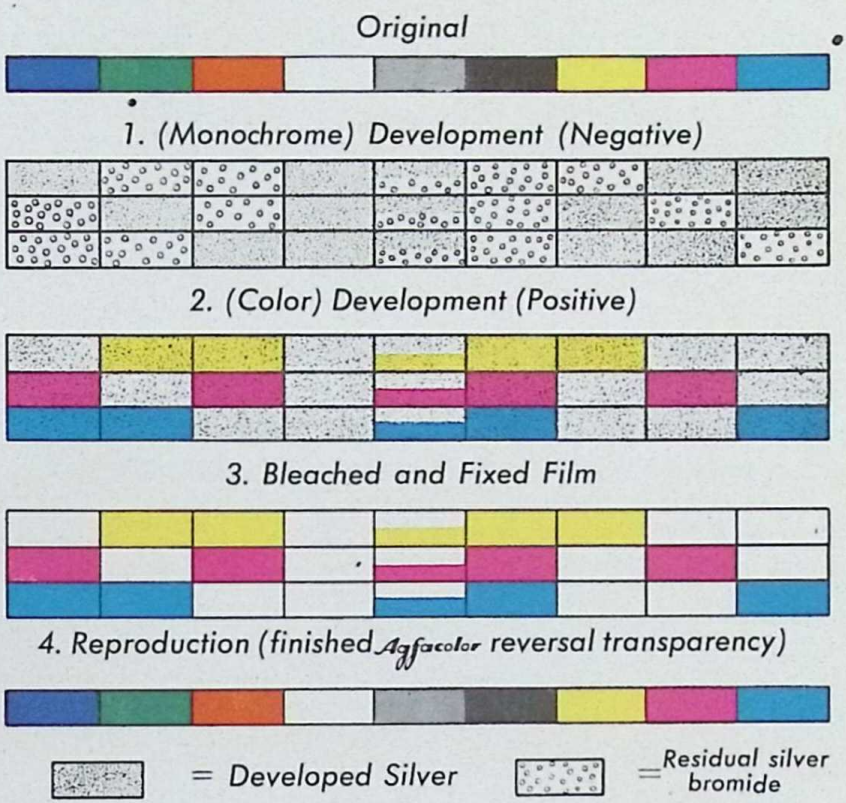


Fig. 25a
Agfacolor Reversal Process.
The colors of the original are recorded according to the sensitivities of the three layers and developed, as a first step, to a monochrome negative. The undeveloped silver bromide remains in the unexposed spots and subjected to a "second exposure" in diffused light. This is followed by color development of this residual silver bromide with the production of black silver and the dyes. The third step consists in the bleaching and removal from the three layers of the black image silver produced during first and second development. Only the dyes remain in the film reproducing the colors of the original suitable for viewing by transmitted light.

cover this operation. The code figures 30 50 00 would thus indicate a combination of 30 yellow and 50 magenta units, while 20 00 70 would indicate a combination of 20 yellow and 70 cyan units.

The Agfacolor printing filters are the sole accessory required for the Agfacolor negative-positive process which is not used in the ordinary monochrome process of photography. To keep their use as simple as possible, moreover, they are made as glass filters which are used either between the lamp and condenser of the enlarger, or else on the diffusing screen of the printing box.

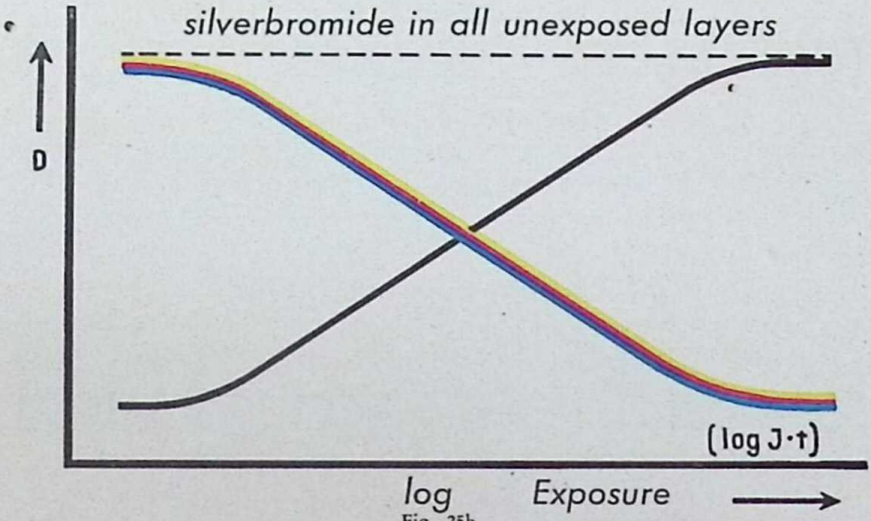


Fig. 25b
Agfacolor Reversal process
To build up the photographic image, initially the entire amount of silver bromide present in the emulsion layers is available. During exposure and subsequent processing quantities of silver bromide corresponding to the brightness values of the original are affected and developed in monochrome. Bright portions of the original result in large, dark portions in small amounts of reduced silver. Conversely, there also remains in the emulsion little and much residual silver bromide respectively. This residual silver bromide is now exposed before reversal development which follows immediately and is coupled with the production of the dye-image. Thus the same colors and brightness values as present in the original are obtained.

Test print

The reader should now be familiar with the need for Agfacolor printing filters and their general use, but it is important to make it clear that it is not until a great deal of practical experience has been gained in printing Agfacolor negatives that a suitable printing filter can be chosen just by visual inspection of the negative itself. For this reason, it is essential for the beginner to start by making a test print without a filter from each negative, and to choose a printing filter by estimation of the result shown. In all cases, *the printing filter must be the same color as the cast it is required to remove.* (Cf. fig. 28.) A magenta cast requires a magenta printing filter to remove it, since it is caused by too low a color density of magenta in the original negative; a yellow cast needs a yellow printing filter, and a red cast a combination of yellow and magenta filters. (See fig. 29a, Plate VI, fig. 31a, Plate X and fig. 32a, Plate XIV). Other color casts are removed on the same principles, either by a single printing filter or a combination of two filters. On no account, however, should three printing filters of different colors be used together, since the effect of combining the three subtractive primary

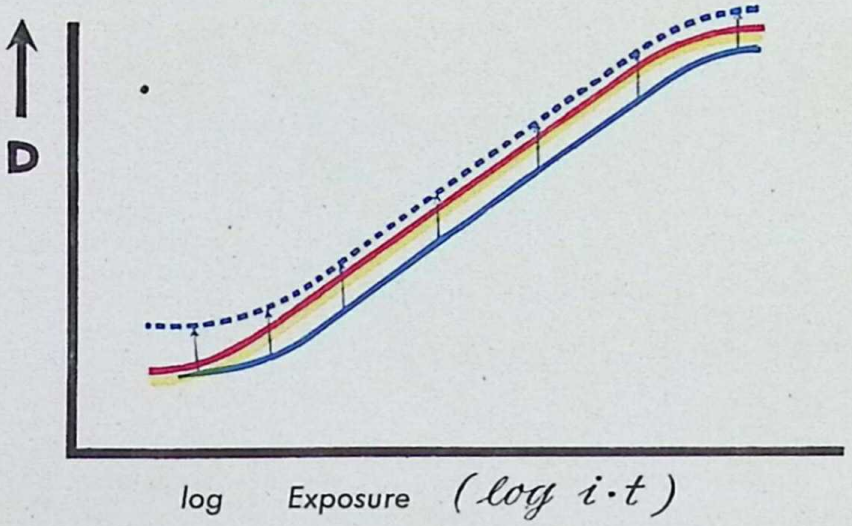
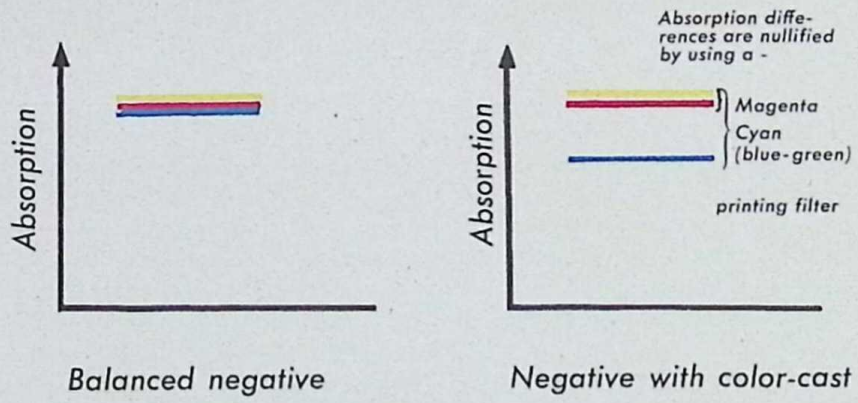


Fig. 26

First type of color-cast on Agfacolor negative (schematic).

(a) The color density curves in an Agfacolor negative with a color-cast are displaced vertically from one another. This may result from variations in sensitivity or exposure, or from various other causes. The curves may be made to coincide by using a suitable printing filter, which has in this case the effect of raising the lower blue-green curve vertically as shown by the arrows until nearly the whole of the curve length coincides with the yellow and magenta curves.



(b) The relative color densities of a balanced negative (left) and a negative with a color cast (right) are shown in terms of absorption. The absorption differences between the individual image layers of the film are corrected — in the present instance by magenta and cyan (blue green) printing filters. The density of the cyan filter in this case should therefore be higher than that of the magenta filter.

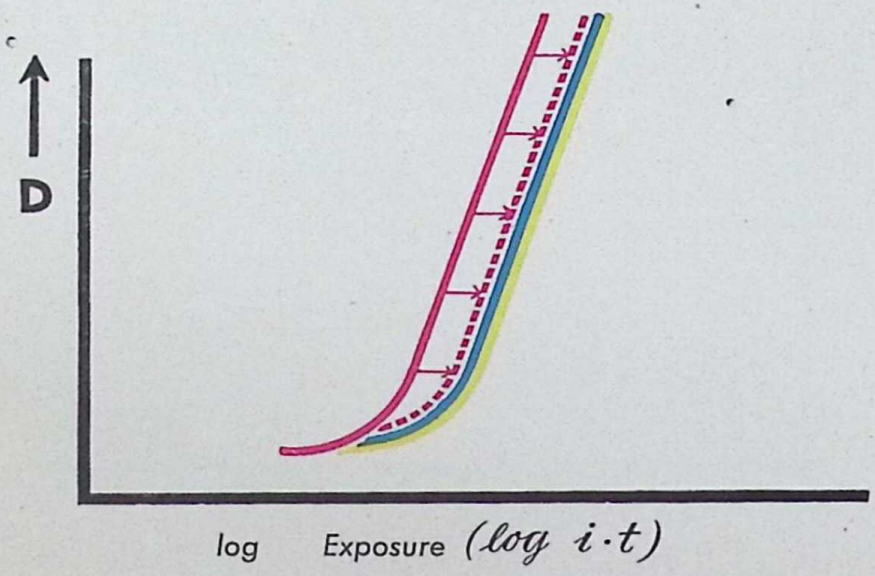


Fig. 27

Agfacolor positive with color cast (first type) schematically.

In the case of the positive the flush is due to the curve for one color being displaced horizontally from coincidence with the others. This may occur through variations in sensitivity or exposure, or from various other causes.

The curves may be made to coincide by using a printing filter, which moves the non-coinciding curve horizontally in the direction of the arrows above, and thus allows coincidence, and thus a neutral grey tone scale, to be obtained. In the present example the use of a magenta filter reduces the effective sensitivity of the green sensitive emulsion that produces the magenta dye-image, and thus allows a neutral grey to be obtained.

colors is merely to produce a grey tone. In any case, it is only necessary to correct the position of two color density curves to make them coincide with the third curve. It is, of course, not only necessary to determine the color the printing filter must have — it is also necessary to determine the exact color density needed to remove a given density of color cast. This may naturally be done by the hit-and-miss principle of making trial prints with increasing densities of printing filter until the best result is obtained, but such a method is altogether too wasteful in time and raw material to be practical. A great deal of energy has therefore been spent by Agfa in devising a simple and reliable method which will indicate quickly and accurately just what printing filter density is needed to give a "balanced" color print. One result of the experiments is that of using a mosaic filter when making the trial print. The Agfacolor mosaic filter has 36 small fields, each with a different printing filter density, and indicates the effect of two different filter colors, as well as combinations of the two,

Agfacolor mosaic filter

simultaneously. The fields increase in density by 20 color units at a time, so that each mosaic filter shows the effect in printing of 00,20, 40, 60, 80, and 99 units of two filter colors on their own, as well as all possible combinations of the two. The one field of the filter which is uncolored is marked for identification, each set of 36 fields is repeated eight times in the whole area of the filter, and the three mosaic filters supplied cover separately and in combination the colors yellow and magenta, yellow and cyan, and magenta and cyan respectively. (See fig. 30 Plates VIII and IX.) This arrangement of repeated groups of filters in the mosaic combination is much simpler to use than one mosaic group, and was suggested to Agfa by W. NALLINGER.

To determine the required printing filter, the mosaic filter is placed over the Agfacolor Paper in enlarging, or between negative and paper in contact printing, in such a way that it covers the more important subjects of the picture. A test print is now exposed and developed, and on examination it is then possible to determine the effect on the print colors of the printing filters and combinations of filter densities. (Figs. 29b, Plate VI; 31b, Plate X; 32b, Plate XIV.)

Yellow	color-cast	is removed by a	Yellow printing filter
Magenta	color-cast	is removed by a	Magenta printing filter
Cyan (Blue-Green)	color-cast	is removed by a	Cyan (Blue-Green) printing filter
Red	color-cast	is removed by a	combination of Yellow + Magenta printing filters
Green	color-cast	is removed by a	combination of Yellow + Cyan (Blue-green) printing filters
Blue	color-cast	is removed by a	combination of Magenta + Cyan (Blue-Green) printing filters

Fig. 28
Printing filter colors to counteract color casts occuring in the Agfacolor Negative-Positive Process

The purpose of the eight-fold repetition of the pattern of 36 filter combinations is to make it quite certain that every combination

present will appear at least once in an important area of the picture, and thus to make the identification of the "corrected" colored print more accurate and certain. The search for this "corrected" color reproduction is simplified by using a mask (shown in fig. 30d) with eight square holes in it: when laid on top of the print square to the image of the mosaic filter, the portions of the print seen through the holes have all the same color correction, and by moving the mask round the effect of different filter combinations can be seen at eight different points of the subject. In this way the required combination of printing filters for a given negative is found, and this filter combination applied to the enlarging or printing-box lamp before making the final print. (Figs. 29c, Plate VII; 31c, Plate XI; 32c, Plate XV.) It will be seen that the printing filter is readily and quickly determined with the minimum cost in raw material.

It is naturally possible, particularly when one is inexperienced in the process, to find that the fields of the mosaic filter which show the correct filter combination do not happen to fall on areas of the print that are important, or where slight color differences are readily distinguished. In this case, it is necessary to make a second trial print with the mosaic filter in a different position, and examine this as before. On the other hand, however, it will not be found necessary to make a trial mosaic-filter print for each and every Agfacolor negative that appears: in general, if one has to make prints from a strip of negatives on a single film, it is not necessary as a rule to determine the printing filter for more than one of them, for within the single strip of film the correction required will remain constant in most cases. Other printing aids have been evolved in such as the Colorax outfit (supplied by Messrs. Stumpf & Schüle, Beuren, Krs. Nürtingen), the E. K. Strip Printer (Suppliers: — Messrs. Erich Kaiser, Offenbach/M., Domstr. 18), and the Colormeister (made by Messrs. Planbograph, Munich 9 Peisenbergstr. 24). The first two printing aids work on the principle of strip exposures through different filters from which the appropriate one will be chosen. The advantage of these instruments over the mosaic filters consists in the exposure each time, of the same picture area onto the strip. In the Colorax apparatus the individual filtering of the strips is effected by automatic insertion of the different printing filters in all three filter colors (see fig. 33b). These printing filters are thus part of the Colorax unit. When the E. K. Strip Printer is used (see fig. 33a), the various printing filters must be changed in the enlarger according to requirements. Hence, the Colorax apparatus is more versatile, and accordingly more expensive, while the E. K. Strip Printer is simpler,

cheaper, but with a more limited application. The Colormeister stands halfways in between the two strip printers just described and the mosaic filters. Here closely adjacent picture areas are automatically exposed in succession through filters built into the unit (see fig. 33d). These three instruments differ from the mosaic filters by requiring several successive exposures. Further details about these printing aids may be obtained from their makers.

The same factors as already mentioned in connection with the mosaic filters apply to all these filter determinators: — They are printing aids, and it is obviously the endeavour and aim of every Agfacolor user to determine the required filter combinations directly from the Agfacolor negative, eliminating the intermediate step of a test print. This wish has been fulfilled since the publication of the first edition of this book through the production of the Agfacolor Comparator (Messrs. Ferdinand Homrich & Sohn, Hamburg-Altona, Gr. Rainstr. 41—43). The Comparator is based on the following principle (fig. 34a): — A negative is printed on Agfacolor Paper through its optimal filter combination; the filter-combination for this negative is thus known in the case of a given emulsion batch number of Agfacolor Paper. The filters are inserted into the light-path from the known Agfacolor negative, which is viewed together with these filters. Into the second light-path of this instrument the unknown negative, whose filter-combination is to be determined, is inserted; also, a sufficient number of printing filters is added for the new negative to present the same overall color to the eye as the known negative together with its own filter combination. The set of filters thus obtained is then used with the new unknown negative in the printer and will, in most cases, and after some practice, immediately produce a correctly balanced print. The Comparator also incorporates a device with which to match the densities of the two negatives to be compared. This is particulary valuable since unequal densities of the negatives (fig. 34b) to be compared easily lead to wrong filter determinations.

The possibilities of removing color-casts by the methods just described are of course important in any subtractive negative-positive color process, and the need for such correction of color will probably correctly balanced never be completely got rid of. But it must be kept in mind that where a print can be made direct — i. e. without any correcting printing filter — to a color reproduction, not only is the printing process simplified, but the reproduction of colors is at its highest level of perfection. A negative which has required a high-density printing filter to correct it cannot be expected to approach

Fig. 33
Agfacolor-printing aids

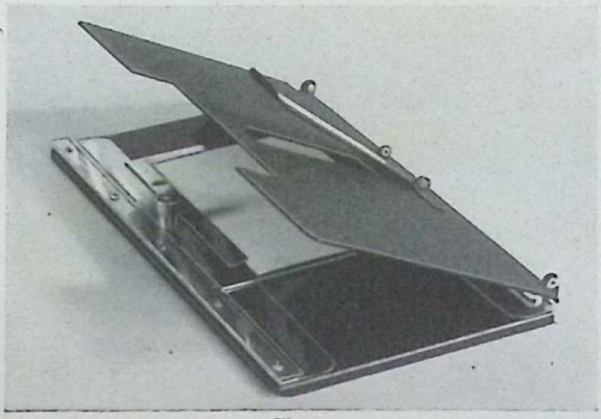


Fig. 33 a
E. K. Strip Printer

Fig. 33 b
Colorax

the same level, for the effect of such a printing filter is always somewhat stronger on the thin and transparent parts of the complementary-colored negative than it is on the dense and strongly colored areas. This means that the filter starts to behave as a color negative, and not just as a general filter. Because of this, the color reproduction in the shadows is different from that in the lighter tones

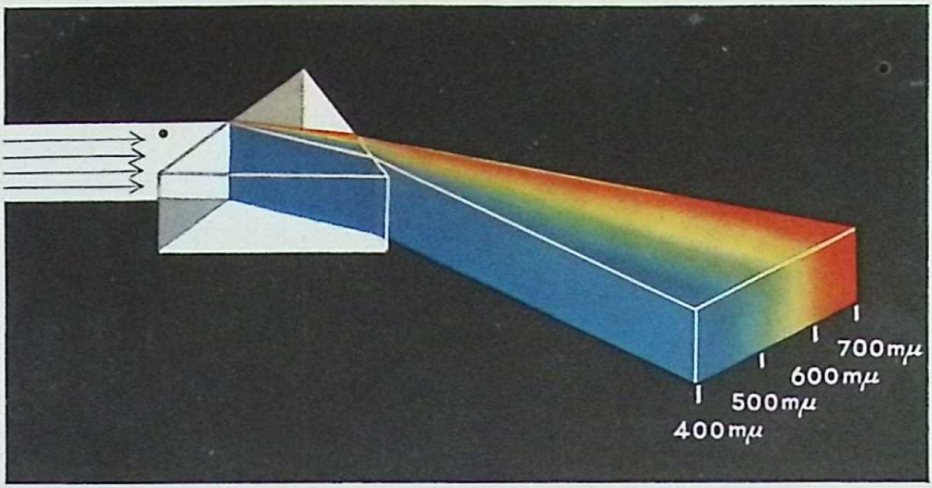


Fig. 1

White light passing through a prism is split up into its component colors, and the visible spectrum of colors results. Short-wavelength colors (blue) are more strongly refracted from their original beam direction than longer wavelengths (red), so that the colors are crowded together at the red end of the spectrum.

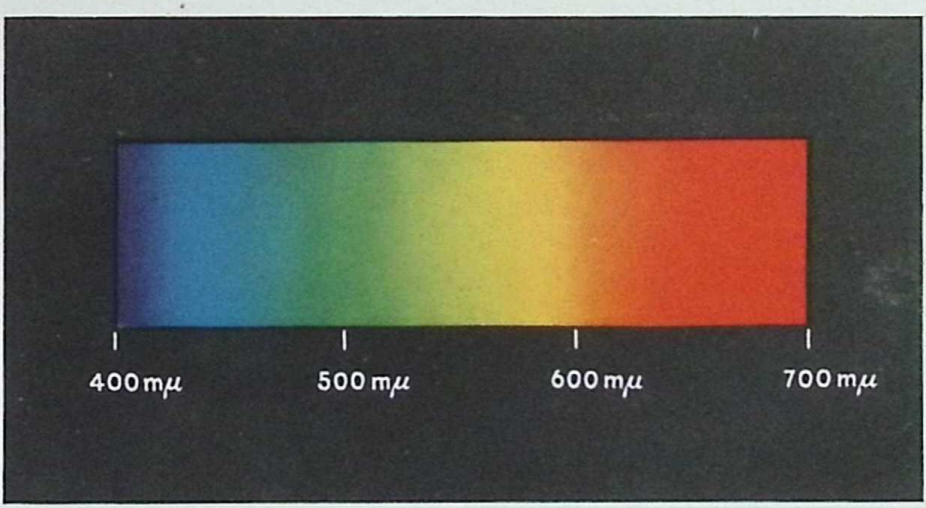


Fig. 2

It is also possible to produce spectra in which the scale of wavelengths is uniformly divided. In these diffraction spectra the eye perceives in the main three colors — blue, green and red each of which occupies approximately one third of the length of the spectrum. Between these regions lie narrower bands of cyan (blue-green) and yellow.

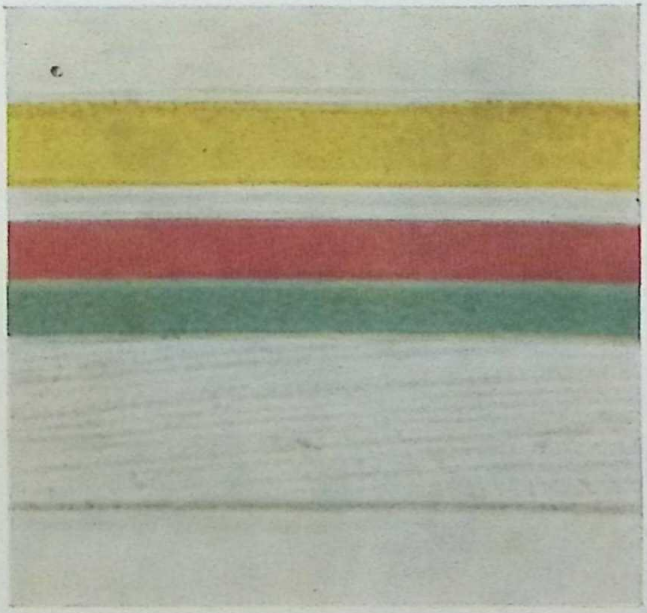


Fig. 7b
Vertical section through Agfacolor film as seen under the microscope.

Fig. 18
Agfacolor negative in complementary colors.

The Agfacolor negative not only shows lights and shadows reversed: whites as "minus whites" or blacks and vice versa, but also all colors similarly. Blue appears minus blue or yellow; green as minus green or magenta, and red as minus red or cyan (blue-green).

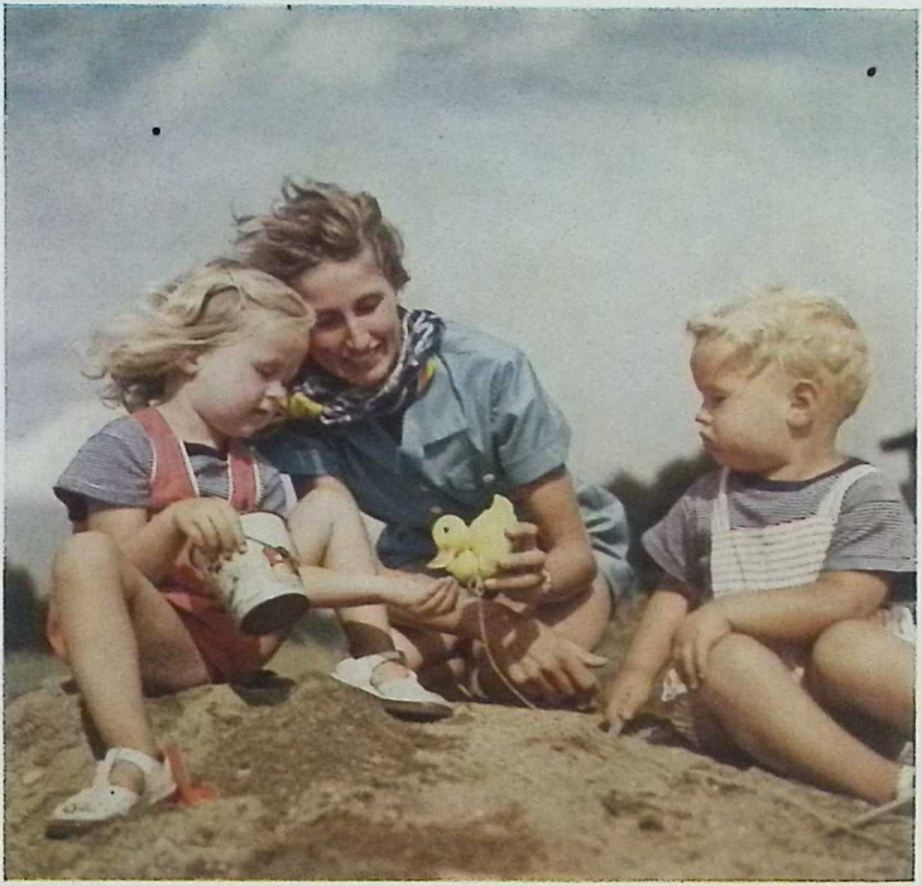


Fig. 19

Agfacolor print from the negative in complementary colors shown in fig. 18.

On being enlarged on to Agfacolor Paper the lights and shadows of the print become those of the original subject, in the usual way, while the complementary colors of the negative become the original colors of the subject. The yellow sky of the negative becomes blue in the positive; greens return to their correct colors, and the cyan (blue-green) lips of the girl in the negative become red once more.

Plate 4

The person and the landscape harmonize well in this picture. (Photo by Dr. A. Miller)

Fig. 33 c
Colormeister

of the print, since extra color, complementary to the hue of the heavy printing filter, is added to them. (Fig. 31a; fig. 31b, Plate XVI.) The filter, in fact, "prints through" in the shadows, while leaving the lighter tones unaffected.

Printing through

This particular effect is specially likely to appear where negative material intended for daylight use is exposed in artificial light, and vice versa. Artificial light usually contains much more red and considerably less blue than daylight, so that the blue-sensitive emulsion is underexposed and the red-sensitive emulsion considerably overexposed. This must be corrected in printing by using a heavy yellow printing filter, and the shadows will generally be turned blue

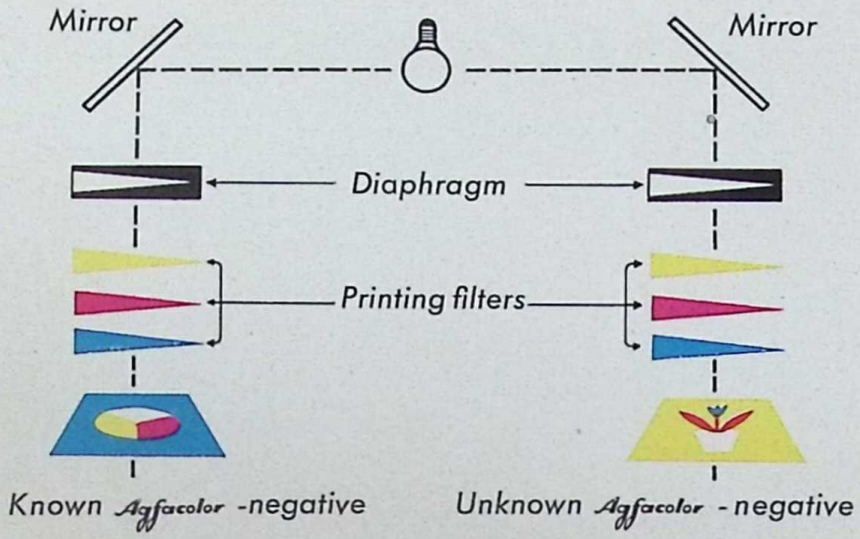


Fig. 34a
Principle of the Agfacolor Comparator.
A negative with a known filter combination is placed in front a light source alongside a negative with unknown properties. Printing filters are insered in the lightpath; the known negative should have that combination which yields the best print obtainable from it; the unknown negative should be viewed through such filters as produce a general color hue as nearly as possible identical to that of the known negative at visual observation. Negative densities are equalized with the aid of diaphragm stops.

in hue by the filter printing through. It is because of this that Agfacolor Negative is made in two types, for use in daylight and artificial light respectively.

Color-cast of the second type

A similar kind of trouble may result from another cause. It was explained at the beginning of the present chapter that a satisfactory color material should reproduce a scale of grey tones as neutral grey, and that this was done by arranging the same color density in the three primary dye-images of Agfacolor Negative and Positive material. (Figs. 23 and 24.) It is possible, however, for manufacturing variations or variations in processing to result in a negative in which the three curves neither completely coincide nor even remain parallel to each other. This results in a "color-cast of the second type", and if, for example, the magenta color density curve is flatter in slope than the other two curves, then the lighter tones of the print will have a magenta cast, while the shadows show a green one, the colour-cast „see-saws". (Fig. 36a, and fig. 36b, Plate XVII.)

See-sawing color-cast

Where this type of trouble occurs, it is obviously impossible to obtain a print that is "neutral" in color reproduction throughout.

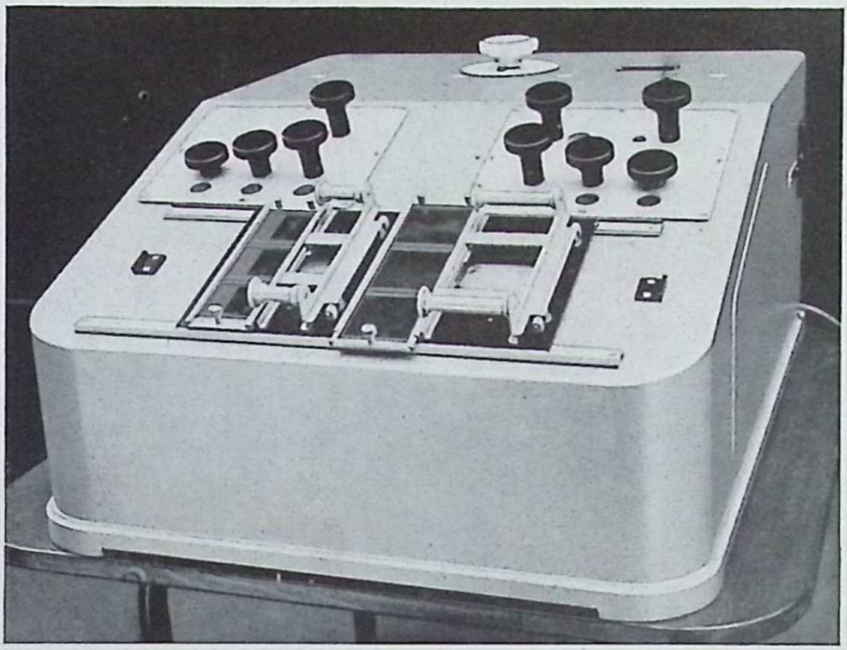


Fig. 34b
Agfacolor Comparator.

There is only one tone of the print that can be neutral at all, while all lighter tones have a cast of one color and all darker tones a cast of the complementary color. The most that can be done with printing filters is to make the neutral tone fall on some point of the tone scale where the distorted color reproduction is least obvious in the final print.

The production of prints from Agfacolor negatives has been described in some detail, because it is felt that this process will represent the major part of color work in the future. Nevertheless there is still a demand for copy transparencies.

Agfacolor Reversal Copying Film

The first demand has been met by the recent introduction of the Agfacolor Reversal Copying Film. To produce copy transparencies, the original transparency is exposed on the copying film, which after special reversal development is turned directly into a copy transparency. This work is undertaken by special reversal processing stations only. However, it should be mentioned at this point that the

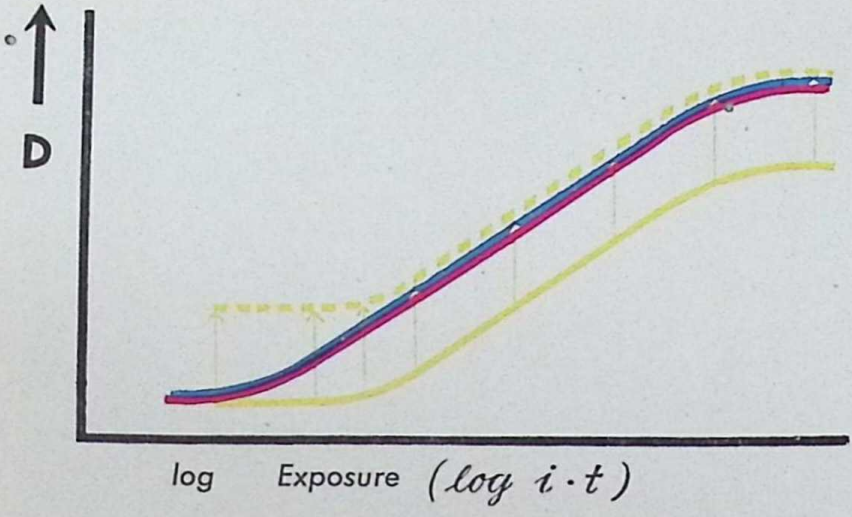


Fig. 35a
Color distortion caused by a high-density printing filter.
As indicated in fig. 24, the action of the printing filter with an Agfacolor negative is to move the color density curve that is incorrect upwards vertically into coincidence with the other two curves. Where a printing filter of high density must be used, the filter density is higher than the fog density in the negative, so that the negative shadows are more heavilyfiltered tan te other image tones. Tis may be considered as the filter "printing through the shadows", and these shadow tones will appear a different color in the print from the test of the image. In the example here, a yellow filter of high density as been necessary to correct the lighter tones, so that the shadows will be more blue in hue than the rest of the image. In general, the "printing through" of the filter in these cases will make the print shadows assume a general hue that is complementary to that of the printing filter.

printing of reversal films principally involves the same factors as have been described in connection with the Agfacolor Negative-Positive Process (First and Second Order Color Cast). But to remove a color cast from a reversal print, filters of the color complementary to that of the cast must be used, instead of those of the same color. Red cast, for example, should be countered by a cyan filter. The explanation is to be found in the wellknown fact that reversal film reproduces the colors as they appear on the original instead of their complementaries as in the case of a color negative. If, therefore, a copy of a red transparency is to be reproduced with a reduced red, i. e. increased cyan, content, a cyan filter must be used. The same principle applies to other color casts as laid out in the scheme shown in figure 37.

Paper prints from transparencies

Basically, the simplest and best way to obtain paper prints from transparencies is through a negative — in complementary colors — of the given transparency. This color negative results in a paper print or enlargement in the same way as would be obtained by the

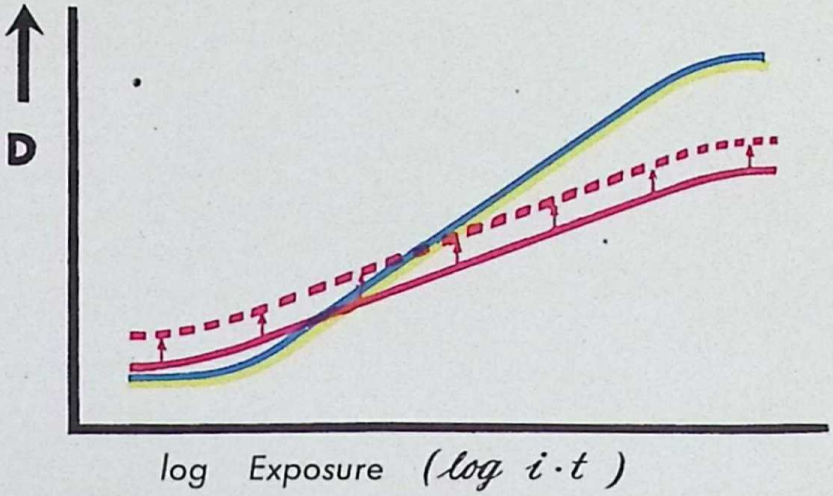


Fig. 36a

Second type color-cast on Agfacolor negative material.

A second difficulty may cause color distortion in Agfacolor images. For various reasons, one or two of the color density curves may not be parallel to the third, and in this case a neutral grey tone can only be produced at the particular exposure level where the three curves intersect. The use of a printing filter can only move this point of intersection to a neutral different tone value in the image, so that the lighter tones show a different reproduction of color from that in the shadows: lighter tones show a color-cast of the color that has the flatter curve, while the shadows show a flush of the complementary color, the color-cast „see-saws". The same type of trouble may also occur on Agfacolor-Paper.

negative-positive method. This potential process, however, will not work satisfactorily until a special negative material is available which will produce these copy negatives. When the normal Agfacolor negative emulsion for artificial light is used, the color reproduction will never be at its best, as this normal color negative material is designed for the photography of original subjects, and not for the production of copy negatives. For the time being, color prints from color transparencies can only be made by means of an additional grey mask to the transparency and a color internegative (cf. chapt. H.)

To conclude this chapter, a few words on the general aspects of color reproduction may not be out of place. First, when the innumerable demands which must be fulfilled for a perfect color print are considered in relation to the limited number of technical methods available to deal with them, it will be realised that all practical color processes involve a compromise of some kind. Second, even the most perfect three-color process cannot reproduce exactly every

Yellow	color-cast	is removed by a	combination of Magenta + Cyan (Blue-Green) printing filters
Magenta	color-cast	is removed by a	combination of Yellow + Cyan (Blue-green) printing filters
Cyan (Blue-Green)	color-cast	is removed by a	combination of Yellow + Magenta printing filters
Red	color-cast	is removed by a	Cyan (Blue-Green) printing filter
Green	color-cast	is removed by a	Magenta printing filter
Blue	color-cast	is removed by a	Yellow printing filter

Fig. 37
Printing filters to counteract color casts in the producion of copy transparencies.

natural color, so that color reproduction in a three-color process print is also something of a compromise. It must thus not be expected that the Agfacolor materials at present available will give an absolutely correct reproduction of natural color, although practical results will indicate the high level of reproduction they can give. No color positive, however, will appear just as the original subject in hue unless it is illuminated by light of the same color quality. Many colors are greatly changed when viewed in artificial light (half-watt electric lamps) as compared with their appearance in daylight: blues are darkened by the artificial light, and violets and magentas reddened. But in any case the practical results show the quality of present achievements. In addition, successful research has led to an improvement in the standard of color reproduction of the Agfacolor Negative-Positive Process, through the introduction of a special technical procedure, the masking method. This is dealt with in detail in the next chapter.

C. Masking

Excellent color photographs impress our eyes as natural and beautiful although direct comparison with reality leads tho the conclusion that the reproduction of individual colors is not strictly true to nature. In the case of a straightforward color process this defect has to be accepted in the interest of a method which should be both as uncomplicated and economical as possible. If, nonetheless, color photographs produced by this method have received an enthusiastic welcome, this, on the one hand, is proof that the human eye has no absolute memory for colors as the ear may have for sounds, and, on the other hand, of the high quality of the material available.

Close comparison with reality reveals mainly two defects in color photographs: —

1) The colors are not brilliant enough (lack of color saturation),
2) the colors are not in all cases true to nature (defective color rendering).

Neither fault would occur if the component dyes had the ideal properties described on p. 25. Since it has up to the present not been possible, and will hardly be likely in the future to produce such ideal dyes, we are up against basic defects inherent in every color-photographic process based on the principle of color-coupling development. Even the introduction into the Agfacolor negative material of negative dyes with widely separated absorption curves could only mitigate these faults without altogether removing them. Beyond this, additional measures have to be taken which neither occur in the normal working sequence nor are they part of the process itself. These measures necessarily render the production of the prints more expensive and are on the whole economically justified only if for various reasons the standard of reproduction required is to be above average, as in the case of exact rendering of colored subjects, carpets, colored maps, or where a particularly high degree of color saturation is essential, as, for example in advertising matter or cinema publicity. Use of photographic masks eliminates the two defects just *Masks*

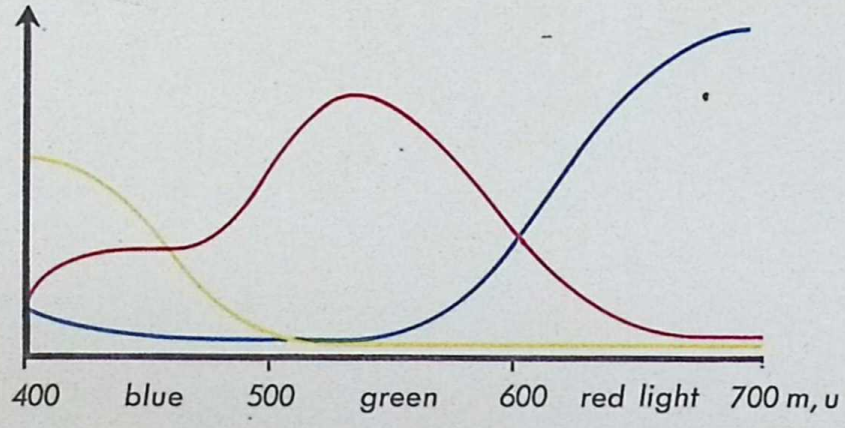


Fig. 38

Absorption characteristics of the dye components in the Agfacolor Negative Film.

The properties of the dyes used in the Agfacolor Negative Film in some cases diverge rather strongly from the ideal (cf. Fig. 9). E. g., magenta absorbs blue light which it should transmit totally (secondary color density); it also shows noticeable faulty ("secondary") absorptions in the red part of the spectrum; similarly, the cyan dye absorbs in the blue part. The yellow dye approaches the ideal most closely.

described. Masks are employed in order to cover up something — we know that from photographic practice. Their density distribution is in every instance opposite to that of the original film.

A mask of a negative is therefore a positive; if used with a transparency, it is a negative. The simplest way to obtain these masks is to print a positive of a negative, or, conversely, a negative of a transparency on a photographic film. Two different kinds of masks are employed:

1) Neutral or grey masks (silver masks), and
2) colored masks.

The grey masks serve to increase the color brilliance (color saturation), thus removing the first defect. The color masks correct additionally faults in the color rendering.

Grey masks

1) Increase of color saturation through grey masks (silver masks). Inspite of the fact that Agfacolor Negative Film — in accordance with the theory explained in Chapter B — employs dyes whose absorption bands are as widely separated as possible, ideal absorption characteristics have still not been attained, because the dyes also absorb in regions of the spectrum where they should transmit light completely (see fig. 38). Thus, to give an example, the magenta dye in the negative absorbs additional blue and red light,

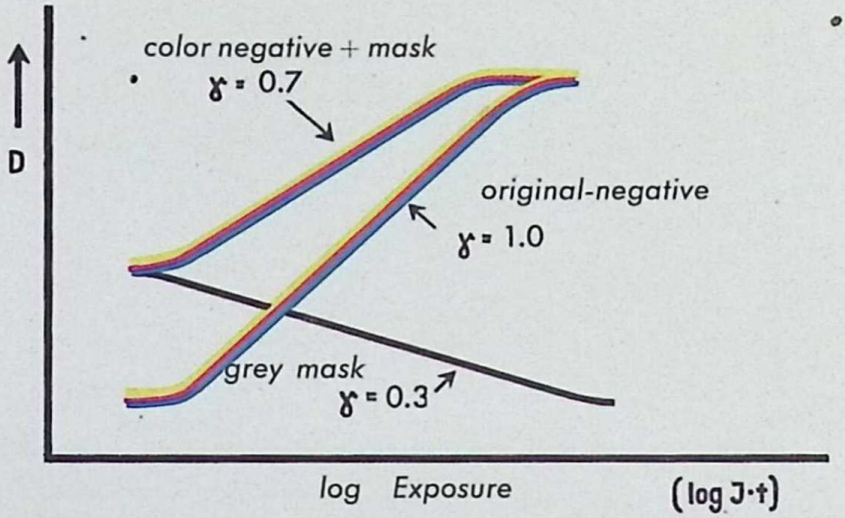


Fig. 39

Action of a flat grey mask on a color negative.

The gradation of the highly color-saturated color negative which had received contrasty development (gamma = 1.0) is reduced to normal (gamma = .7) by the gradation of the positive grey mask. The high color saturation of the contrasty color negative is, however, maintained, as the mask itself is colorless.

and the other dyes, too, hold back parts of the printing light for which they should be completely transparent. This, in effect, prevents the formation of a sufficient quantity of dye in the positive layers affected. In addition to this, the positive dyes themselves show faulty secondary absorptions or secondary densities, resulting in an undesirable white content of the colors, i. e. in decreased saturation and whitening of the colors occurs. Increased color saturation is achieved by the use of a more contrasty negative (prolonged development to a gamma of 1.0 — 1.2 instead of normal development to gamma .7 — .8) together with normal Agfacolor Paper, or of hard Agfacolor Paper together with a normal color negative (gamma .7 — .8), and, lastly, by combining the two "contrasty" materials. In each case, the limiting factor of these measures is the danger of the picture contrast becoming excessive, with highlights too bright and burnt-out, and shadows too dark and heavy. (In this connection it cannot be stressed too much that the correct tone range (gradation) of a color photograph should, in the interest of optimal saturation, always be a primary consideration.)

It is in this connection that the grey mask is most helpful. To increase its gradation, the color negative is given a development which

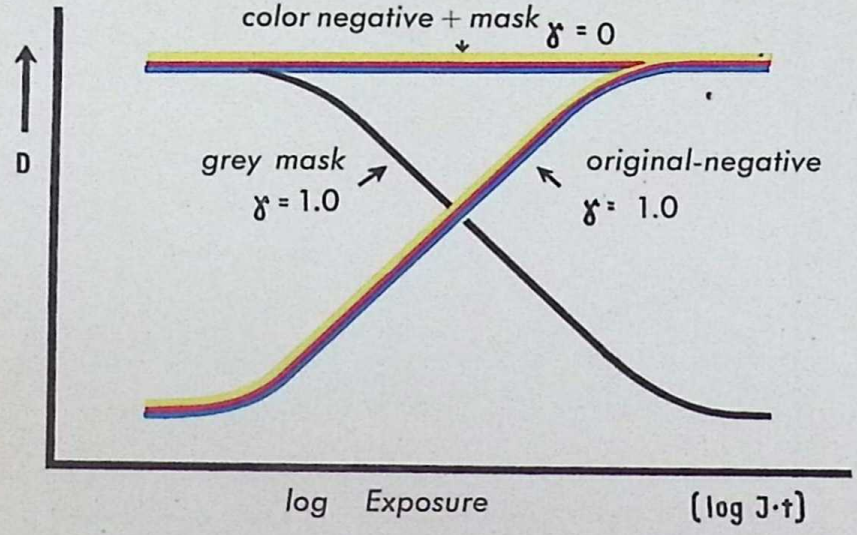


Fig. 40

Action of a grey mask on a color negative of the same gradation.

A grey-mask gradation identical to that oft he color negative results in a gradationless combination, yielding identical color brightnesses in the print, but leaving the color saturation of the negative unaffected.

is considerably prolonged, thus producing more contrast and a gamma value of 1.0—1.2 instead of the normal .7—.8. If this hard negative were printed without a mask, a positive picture would result which, as already pointed out, would have far more brilliant colors, but at the same time its gradation would be too steep. This hard negative, however, is now printed on a panchromatic monochrome film (e. g. Isopan F or Isopan Portrait Film and the print given a very soft development (gamma .3—.4). The result is thus a very weak monochrome positive, the grey mask. This is now brought into precise register with the Agfacolor negative which had a more contrasty development, and used as a printing negative"sandwich". The flat positive gradation of the mask reduces the negative range to normal proportions again (gamma 1.0 — .3 = .7) i. e. that of a normal negative) (see fig. 39). But the brilliance or saturation of the colors caused by the high contrast of the negative persists, since obviously the neutral mask has no effect on it. The same result, of course, is obtained by masking a normal negative and printing it on hard Agfacolor paper.

Naturally, the gradation of a grey mask may be increased at will. The results are interesting but this procedure is certainly not to

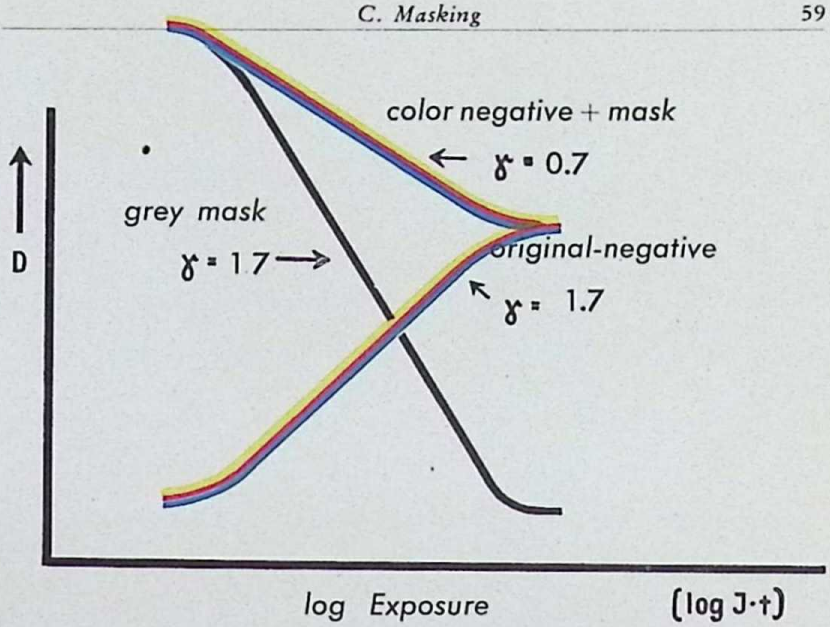


Fig. 41

Action of a grey mask with a steep gradation on a color negative with normal gradation. A normal color negative and a steep positive grey mask result in a combination with a positive brightness distribution. Its effect is a negative picture gradation in the print (bright colors are rendered darker, dark colors of the original are rendered lighter). The colors, however, remain positive retaining the high color saturation due to the color negative.

be recommended for normal work; it may be desirable, though, in special cases, and quite effective. If, for example, the mask is developed to the same gradation as the negative (gamma = 1.0), the print will retain its color saturation, but the picture gradation will be reduced to zero, i. e. all colors in the picture will have identical brightness values although their saturation will be very high. The picture no longer possesses image gradation but shows strongly saturated colors (see fig. 40). If the contrast of the grey mask is further increased, the steeper positive gradation of the print will outweigh the negative gradation of the color negative. Consequently, the picture will have positive colors, but a negative gradation, i. e. the color hues of the original persist, but all bright colors are rendered dark, all dark colors bright (see fig. 41).

Filtering for masks

During exposure of the masks filters may be employed. This, in the positive, has the effect of generally reproducing the color identical to that of the filter darker, its complementary brighter. As, on the whole, yellow is rendered too bright and blue too dark,

exposure of the grey mask through a yellow filter is recommended. (see remarks under 2. color masks).

Masks for transparencies

The use of grey masks may also be of advantage in the production of copies from transparencies. Here, they obviously have negative gradation.

Unsharp masks

Difficulty is encountered when these masks are used with their exact registration, where identical size and contours are absolutey essential. This becomes easier if an unsharp print is made of the masks; instead of the emulsion side of the negative, its back should be in contact with the emulsion of the mask. Contrary to expectations, this does not lead to a loss of sharpness in the final picture. A relief effect will be seen in the picture if there is considerable lack of register (directions for the production of masks are contained in the practical part (Part H).

Register

An improvement in the color reproduction evidently cannot be achieved through grey masks, since they are neutral. This can be successfully done only with the aid of color masks:

Colored masks

2. Improvement of color reproduction through colored masks.

Close comparison with reality of almost all color photographs based on color development will reveal that generally all yellow colors are reproduced too bright, the blues too dark and greens frequently show a blue cast. These faults can be traced almost exclusively to defects of the emulsion dyes in the complementary color negative. If it were possible to produce dyes with absorption characteristics as ideal as described on p. 25, far better rendering of all colors would be assured. Unfortunately this is not the case. Study of the absorption curves of dyes as they are established during actual dye formation in color development (see fig. 38) will reveal that yellow approaches the theoretical postulate closest of all. It really only absorbs in its own region (spectral blue). Green and red are transmitted practically without loss. Cyan is less satisfactory, but still comes rather close to the theoretical ideal because of the well-known fact that in Agfacolor Negative Film it has been deliberately and substantially moved towards the longer wavelengths. Only in the blue region of the spectrum, where its transmission should be complete, do we find a "faulty" absorption of the order of about 10 %. By far the least ideal is the magenta dye. It should absorb in the green region alone, and transmit blue and red completely. In actual fact it absorbs a little in the red region, but extremely strongly in the blue, so that about 40 % of the blue light, which should be passed without any loss, is held back.

Faulty absorption

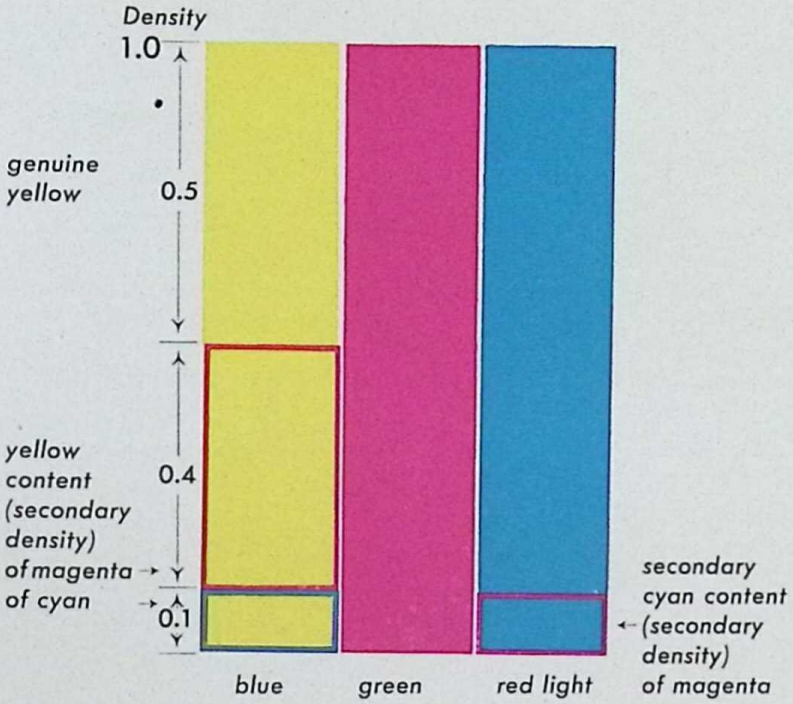


Fig. 42

Proportions of primary and secondary color densities of the dye-components of Agfacolor negatives in the constitution of a grey area.

A grey area in the color negative consists of equal proportions of yellow, magenta, and cyan densities. Yellow, however, only consists of a 50—60 % porportion of "genuine" yellow from the yellow layer. The remainder is contributed by the secondary color densities of magenta and cyan (secondary yellow). The same applies to the secondary density in the magenta of the cyan dye.

If for example a grey area is exposed on a color negative, this is composed of equal parts of yellow, magenta and cyan, since these colors together will produce grey. But the spectrally pure, genuine yellow of the yellow layer only makes up 50—60 % of total content, the remaining 40—50 % being contributed by secondary color densities (yellow content) mainly of the magenta dye and to a lesser degree of the cyan. It is this large secondary color density of the magenta which is responsible for by far the largest proportion of defective color rendering. Special measures could of course be divised to ensure at any rate the formation in the yellow layer of 100 % pure, genuine yellow, which, together with the secondary color

Yellow content

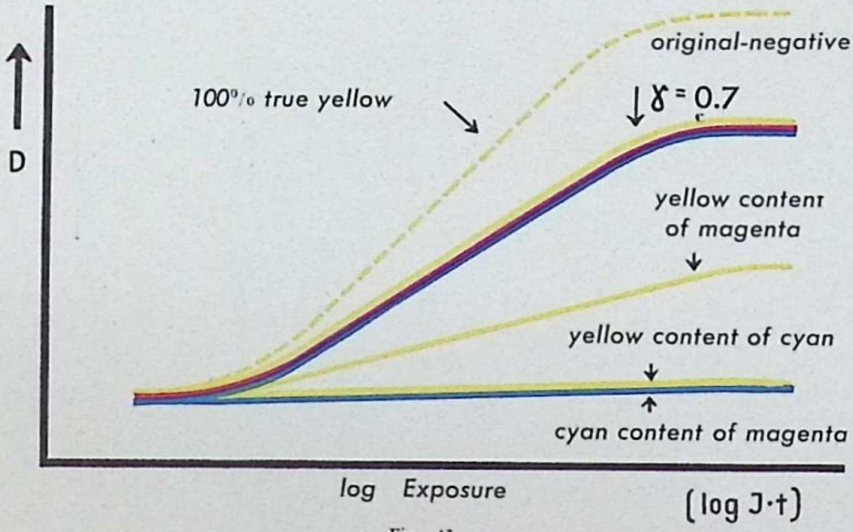


Fig. 43

Proportions of primary and secondary color densities in the color density curves.

In the interest of an reproduction of grey the color density curves determined should be superimposed. However, they do not only consist of the primary densities of "their" colors, but partly also of the secondary densities of "forbidden" colors (e. g. yellow secondary colour density of the magenta). A yellow density consisting of 100 % primary and 50 % secondary yellow = 150 % total yellow would indeed contain a sufficient amount of pure yellow, but have an undue influence on the reproduction of grey, producing a progressive color cast from blue highlights to yellow shadows.

densities of the magenta and cyan dyes would amount to approximately 150—160 % "total yellow" (Fig. 41). This, though, would result in a faulty rendering of grey tones which would appear too blue in the positive and no longer neutral grey, particulary in the lighter portions, owing to the excess of yellow in the negative. Thus the color balance, which is judged by a neutral reproduction of grey tones, would be disturbed. Therefore, in the interest of the factor of color balance, in ordinary color processes this faulty absorption must unfortunately be accepted.

In practice, this has the following effect: — A pure blue sky should produce 100 % pure yellow in the top layer of the color negative. In fact, however, only about 60 %, i. e. too little, yellow (as referred to the "grey postulate") is formed. This decrease in yellow density causes a certain proportion of blue light — in excess, of that composed of 100 % green and red (producing magenta + cyan = blue in the paper print) — to fall on the color paper with the consequent formation, during its development, of yellow dye. This yellow should not be present in the blue, and has the effect ot

rendering it more grey or of whitening it. Conversely, a yellow color in the original will not only be minus yellow, i. e. blue (magenta + cyan) in the color negative, but also contain a proportion of secondary yellow (from the magenta dye). This causes a reduction of blue light falling on the color paper during printing below the theoretically necessary level. Hence, less yellow dye is developed. Yellow is rendered too bright. Also, reproduction of the green of leaves so dominant in nature suffers at times from the faulty absorption of the magenta dye: — in the negative it should appear a pure magenta, i. e. it should pass blue and red undiminished during printing. The secondary color density of the magenta in the blue spectral region, however, does not permit the passage onto the printing material of identical quantities of red and blue light which is required theoretically; blue light is relatively reduced. Therefore, correspondingly more cyan than yellow is formed in the color positive material; since green is made up of these two dyes, th green of leaves will suffer from a blue cast.

Yellow mask

This undesirable effect of the secondary color density of magenta (secondary yellow) can be neutralized by the use of a yellow-colored mask. A positive yellow mask is superimposed on the color negative, or, strictly speaking, on the magenta layer of the negative. It is obvious that thereby the negative secondary yellow (of the magenta layer) and the positive yellow of the mask combine to form a uniform yellow density having the effect of a yellow screen which will no longer cause color distortion (See fig. 44). In theory, the correct procedure would be an exposure of the masking material through the color negative and a green filter, and its development in a yellow color and to a gamma which has 40 % of the steepness of the magenta layer. This yellow mask is then brought into register with the color negative, and this combination used in the printing process. This would certainly eliminate the secondary yellow content of the negative and destroy its effect. Only the genuine yellow would remain. But since its gradation alone would be too flat after the removal of the secondary yellow, the color balance of the „grey postutate" would be upset, with the final appearance of "see sawing" of the colors of the print from yellow highlights to blue shadows. Care must therefore be taken to ensure a primary yellow gradation of a steepness equalling that of the magenta and cyan in the color negative. One way to meet this condition, would be to print the color negative onto a monochrome emulsion through a blue filter, and then develop the positive to the same gradation as the yellow mask, a gamma of, say, .3—.4. A print is made from this monochrome positive, again on monochrome film material. This negative is developed

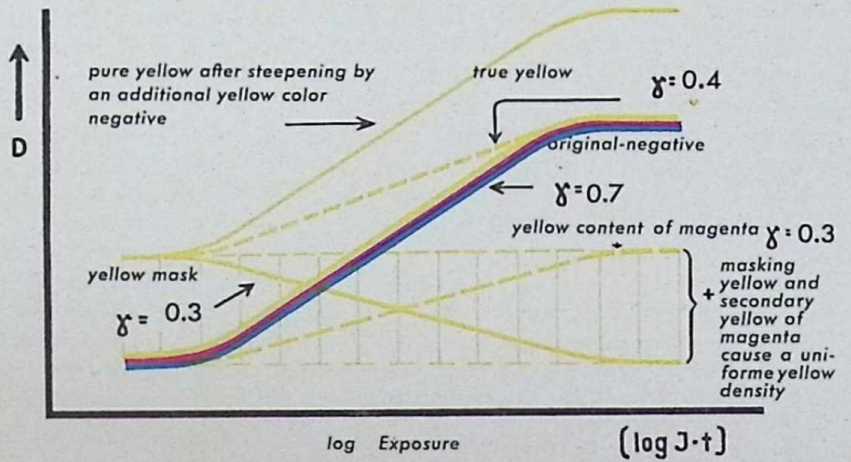

D
pure yellow after steepening by an additional yellow color negative
true yellow
γ = 0.4
original-negative
γ = 0.7
yellow content of magenta γ = 0.3
yellow mask
γ = 0.3
masking yellow and secondary yellow of magenta cause a uniforme yellow density
log Exposure
(log J·t)

Fig. 44

Action of a positive yellow mask on a color negative.

A flat positve yellow mask with a gradation identical to that of the magenta secondary density removes the effect of the latter. The outcome is a uniform yellow density acting like a yellow screen. This leaves the gradation of the primary yellow too flat. An additional yellow negative must restore it to the same value as the magenta and cyan gradations. The actions of such additional yellow negative and a positive yellow mask are combined in a "gradationless" yellow corrective.

yellow, again to a gradation identical with that of the yellow positive mask which had been exposed through a green filter. This yellow negative will then contain pure yellow only. It is brought into exact register with the original color negative and serves as a printing combination together with the yellow positive mask removing the secondary yellow. In this case, then, three films are combined to be used as a printing "sandwich": — the original color negative, the positive yellow mask, and the yellow color negative to steepen the gradation of the primary yellow. Such a combination of several films is of course rather cumbersome to use and its production relatively complicated and time-consuming. There exists a very elegant method of combining these two yellow films, the yellow positive mask and the yellow negative involving the production of a so-called gradationless "yellow corrective". The working procedure is as follows: — As a first step, a transparency is made on monochrome film material through a blue filter, and developed to the same contrast as the original color negative i. e. to a gamma of 1.0. This black-and-white transparency thus contains the total yellow, primary and secondary together, in the form of a positive monochrome picture! This black-and-white transparency is now brought into register with the original negative. This

Gradationless yellow corrective

The subject shown here contains little color, yet the monochrome and Agfacolor versions give by no means the same impression. So few colors and yet a colorful picture.
(Photo by Siv Nebo)

Plate 6

Fig. 29a

Fig. 29b

Fig. 29c

Fig. 29a
Print made without filter, showing yellowish-red color-cast. The yellow/magenta mosaic filter is required.

Fig. 29b
Mosaic print of fig. 27a. The yellow and magenta filtering introduces increasing amounts of blue and green as one moves away from the unfiltered field marked (/). The "neutral" colored fields indicate that a filter combination of 70 90 00 is required in making the final print.

Fig. 29c
Final print made with 70 90 00 combination of filters: the color-cast has been removed.

Plate 8

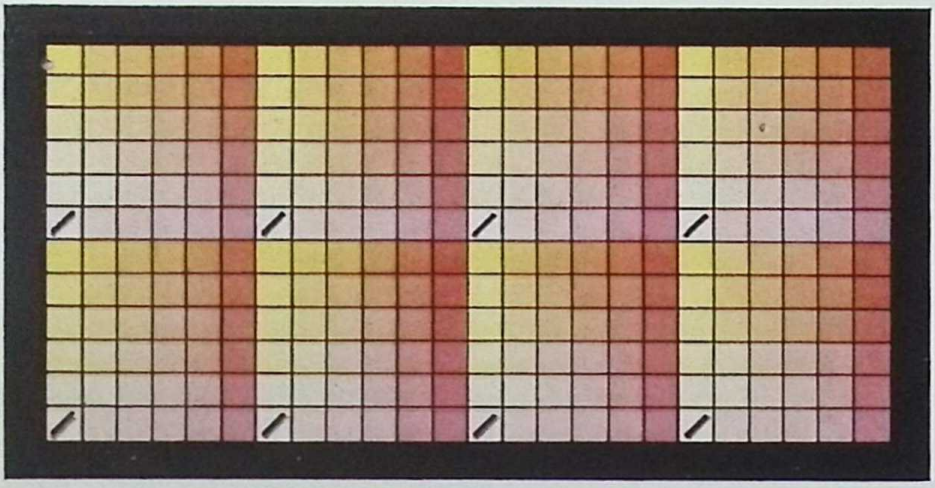


Fig. 30a
Agfacolor Mosaic filter in yellow/magenta (/).

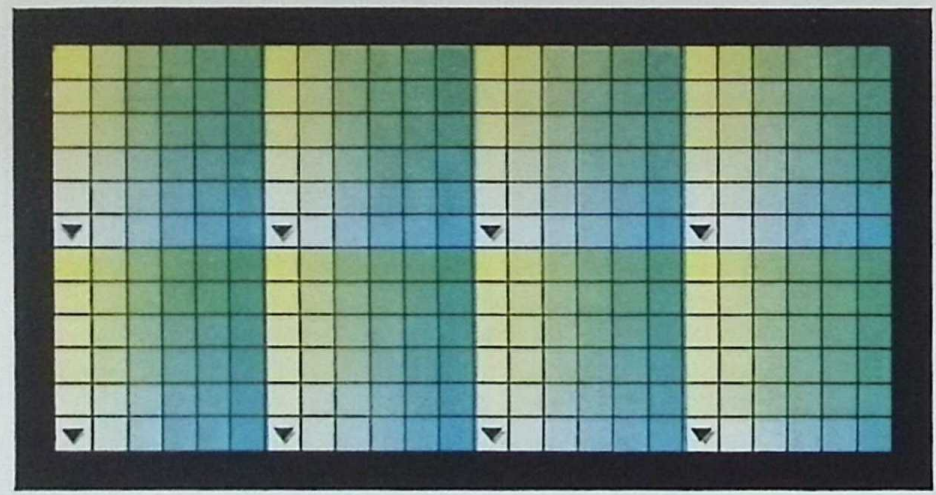


Fig. 30b
Agfacolor Mosaic filter in yellow/cyan (blue-green) (▼).

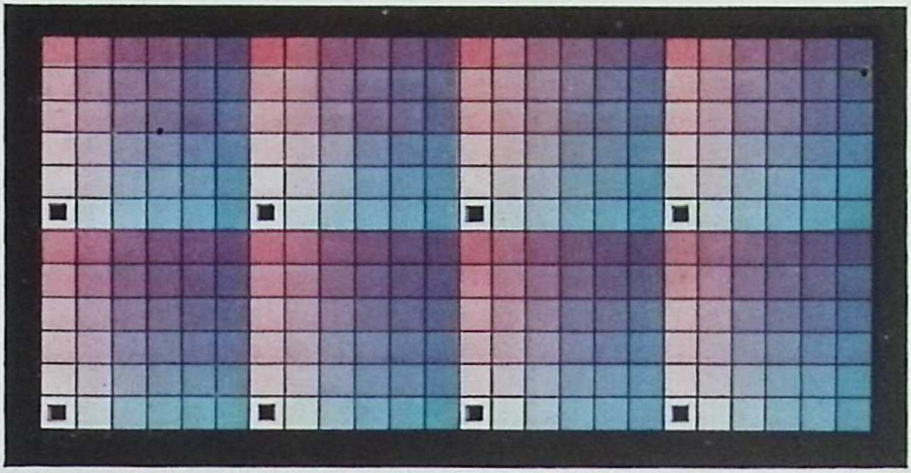


Fig. 30c
Agfacolor Mosaic filter in magenta/cyan (blue-green) (■).

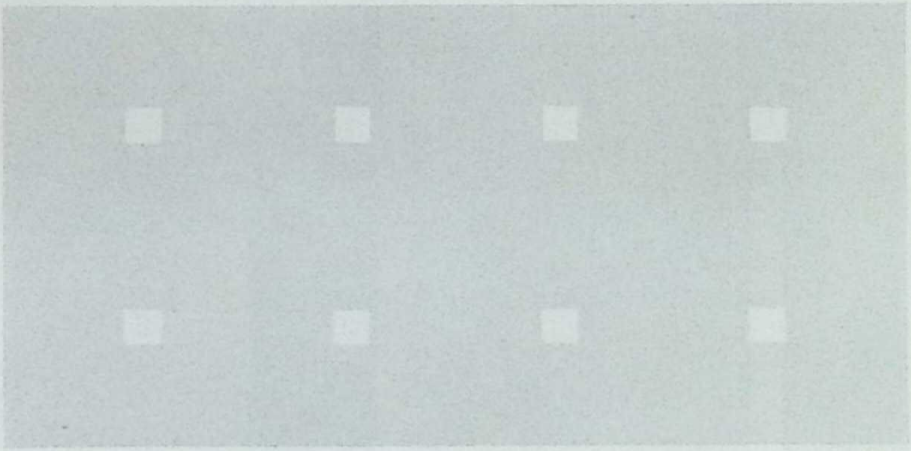


Fig. 30d
Mask with holes used with mosaic filters to isolate the effect of one particular filter combination. The holes show the equally filtered fields when placed on the trial print.

Plate 10

Fig. 31a

Fig. 31b

Fig. 31c

Fig. 31a
Print made without filter, showing blue-red color-cast. The magenta/cyan (blue-green) mosaic filter is required. (■)

Fig. 31b
Mosaic filter print of fig. 31a. The magenta and blue-green filtering introduces increasing quantities of green and red into the print color as one moves away from the unfiltered field (■). The "neutral" print is reached with a filter combination of 00 70 30.

Fig. 31c
Final print made with 00 70 30 filter combination: the blue-red color-cast has been removed.

Plate 12

Risks may even be taken with Agfacolor Negative: here is a winter scene taken right against the light in the late afternoon. The soft and faint colors give the result a charm of its own, quite different from that of a monochrome photograph. (Photo by H. Berger)

Agfacolor is particularly suitable in advertising photography: the direct exposure in color gives punch and dramatic effect to the advertisment. (Photo by I. Strauss)

Fig. 32a

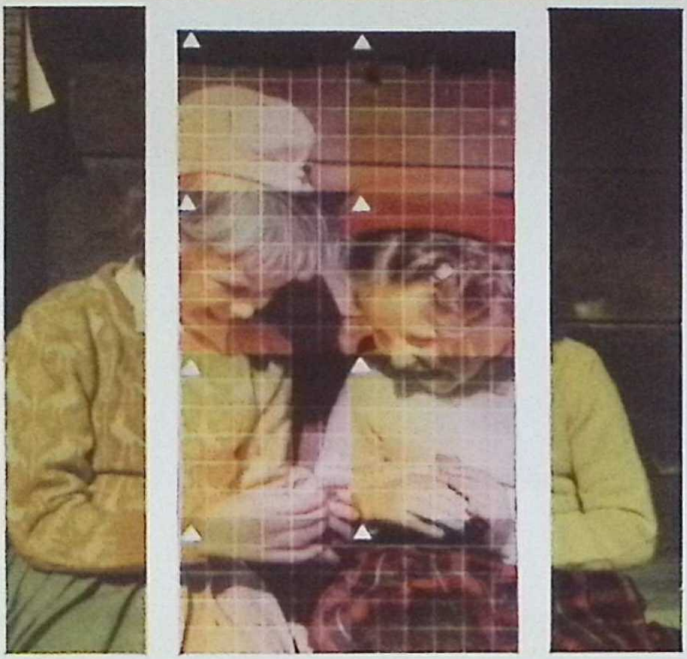


Fig. 32b

Fig. 32c

Fig. 32a
Print made without filter, showing green color-cast. The yellow/cyan (blue-green) mosaic filter (▽) is required.

Fig. 32b
Mosaic filter print of fig. 32a. The yellow and cyan (blue-green) filtering introduces increasing quantities of blue and red into the print color as one moves away from the unfiltered field (▽). The "neutral" print is reached with a filter combination of 30 00 40.

Fig. 32c
Final print made with 30 00 40 filter combination: the green color-cast has been removed.

Fig. 35b

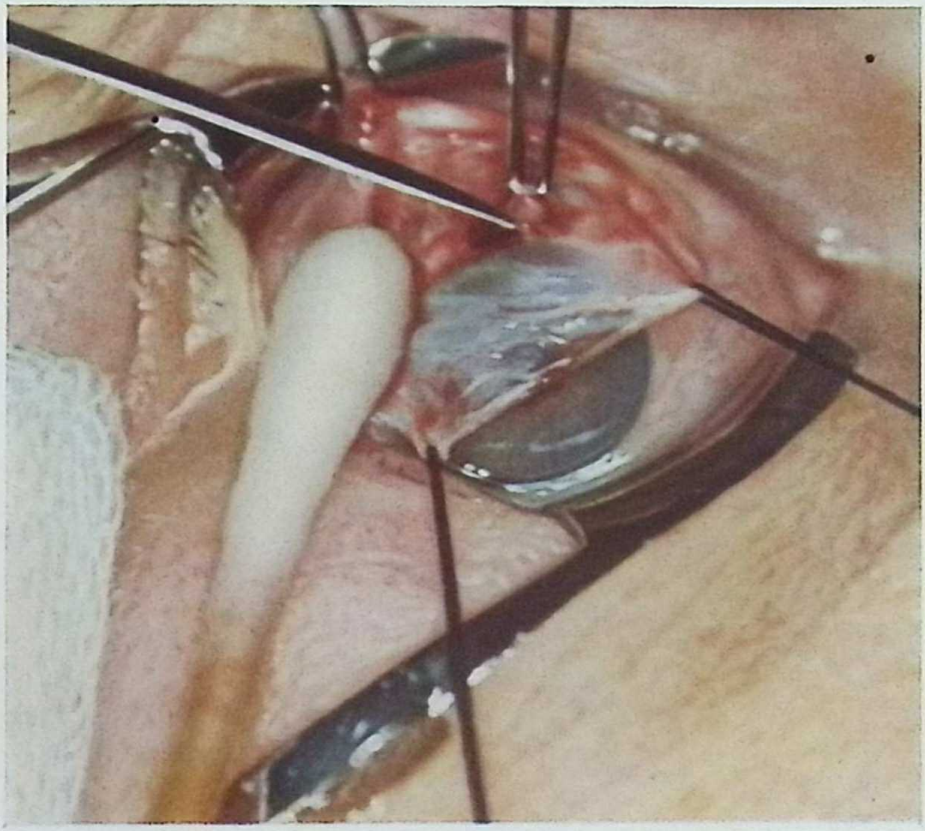
Color print to illustrate fig. 35a, page 52. A very dense magenta and yellow filter combination had to be used for correction, which has resulted in "printing through". The ligther tones tend to be reddish, while the shadows are bluish-green.

Fig. 36b

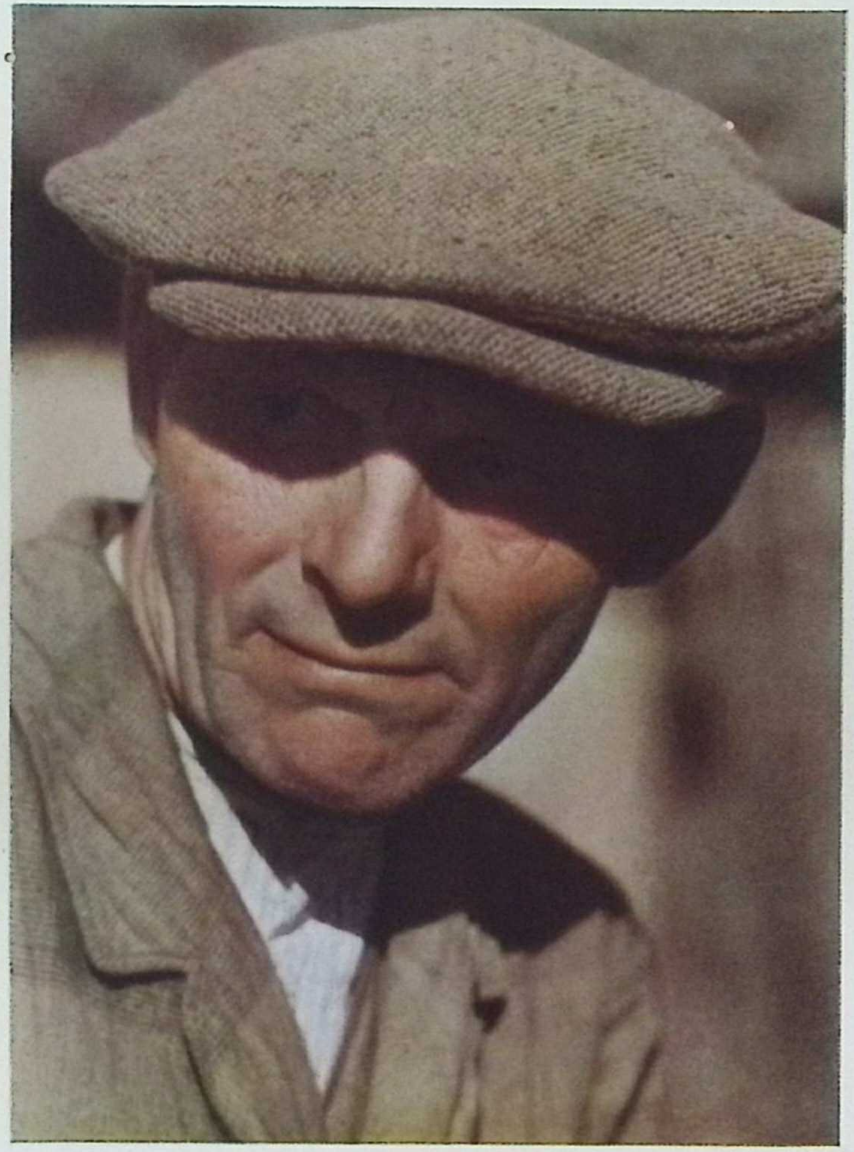
Color print to illustrate the second type of color-cast (fig. 36a). In the negative the color density curve of magenta is flatter than the other curves, so that color tones „see-saw" between magenta lights and green shadows

Plate 18

This Agfacolor picture shows the effect of mixed light. One side of the subject is lit by daylight, and tends to be blue, while the other side is lit by incandescent lamps and tends to be yellowish (cf. fig. 50).



Agfacolor record of an eye operation (green cataract). The importance of the Agfacolor process in science and education will be clear from this print: only a color photograph can show all the subject so clearly and in such immediately recognisable detail. (Photo by Kisselbach, from Thiele, „Ophthalmologische Operationslehre", published by Verlag Georg Thieme, Leipzig.)



The professional protraitist will find a wealth of completely new possibilities when using Agfacolor. The colors enhance the plastic and pictorial effect. (Photo by v. Steinäcker)

combination is exposed onto an orthochromatic or panchromatic monochrome material through a green filter, and the film developed yellow to a "gradation" of .3—.6. This represents the "gradationless yellow corrective". It causes in a single step the removal of the secondary yellow from the magenta secondary color density, and the steepening of the primary yellow gradation in the color negative; as it is itself without gradation, it has no influence at all on the integrated gradation, i. e. the color balance, of the original negative or the final pircture. Convincing proof of this ist the fact that a grey scale incorporated in a color negative will appear without any differentiation of the grey steps in the yellow corrective. If individual steps can be distinguished from one another, the corrective will not be satisfactory. This will be due to the fact that the gradations of the color negative and monochrome positive differ. This yellow corrective is now brought into precise register with the color negative in the place of the monochrome transparency. Both films together serve as a printing combination and result in a considerably improved color reproduction of the picture. The action of this yellow corrective is made clearer by the following example: — When the black-and-white transparency is exposed through the blu filter, all the yellows in the negative will be reproduced as clear or very light densities, and all the blues as fairly heavy densities. When the yellow corrective is made by printing the film combination "color negative + black blue-separation" through a green filter on monochrome film material, all those areas in the color negative containing yellow will transmit the light completely, leading to the formation of yellow in the corrective during development. Where, however, magenta or blue (which, in the negative, was formed partly by magenta) is present, the green light is absorbed. Hence, in these areas, less yellow (magenta secondary density) or no yellow at all is formed during the subsequent color development of the corrective.

The yellow in the corrective corresponding to that in the color negative serves to enhance the primary yellow gradation of the latter, depressed by the mask yellow in the corrective (magenta secondary density). In the final picture, all the yellow colors will therefore be more highly saturated and darker, all the blues will be brighter and more saturated, and all the greens will incline less towards blue, i. e. will be more yellow.

Likewise, a gradationless magenta corrective can be produced and used to remore the secondary color density of the cyan in the green spectral region. As a first step, a black-and-white transparency is made from the color negative through a green filter with the same

gamma as the negative. These two films combined are then exposed through a red filter on panchromatic monochrome film and developed to a gradationless magenta corrective, which is used together with the yellow corrective in combination with the color negative (i. e. three films combined) for printing. This will achieve a still further improved separation of the red and green colors; practically the removal of all the defects in color-rendering can be effected, and quite true-to-nature color pictures be produced. Since, however, defects in reproduction caused by faulty absorption of cyan are relatively negligible compared with the magenta defects, the magenta corrective may be omitted in the interest of a simplified working procedure (directions for the practical production of the correctives are contained in Part H: — Practical Use of Masks, p. . . . .).

To round off the picture, it should be mentioned, that the slight secondary color density of the cyan in the blue spectral region (secondary yellow of the cyan dye) may also be removed through the yellow corrective. All that is required is a second exposure of the yellow corrective through a red filter after it had been exposed through the green filter. In actual practice, however, this corrective is almost entirely without application.

By combining these proceses it is possible to mask simultaneously two dyes or two secondary densities of the same dye. It is however, beyond the scope of this book to go deeper into this problem.

D. The Agfacolor Color Circle

The Agfacolor Color Circle illustrated below has proved most useful as an aid to the understanding of the Agfacolor Process and color photography in general. In this circle, the three additive primary colors blue, green and red on the one hand, and the three

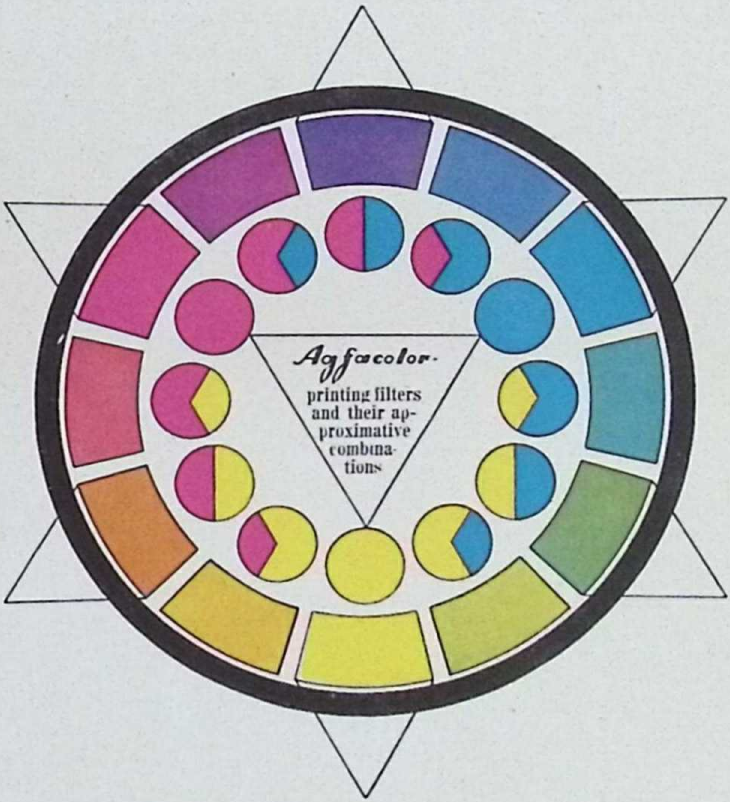


Fig. 45
The Agfacolor color circle

subtractive complementary colors yellow, magenta and cyan on the other hand are so arranged that members of the pairs of complementary colors are facing each other; e. g. magenta is opposite green, blue opposite yellow. Moreover, these six colors are marked with pointers. These color-triplets also indicate the sensitization of the individual layers of the Agfacolor emulsion, to their respective color components: — green sensitization, for instance, correspond to the magenta component opposite the green in the color circle. Furthermore, it can be seen from the color circle that the Agfacolor negative reproduces original colors as their complementaries, i. e. yellow colors as blues (opposite yellow in the color circle), green colors as magentas.

Between these colors are to be found six additional colors, representing mixtures of the six basic colors. In turn, color circles related to these colors indicate the approximate combination of Agfacolor Printing Filters to remove a color cast corresponding to the colored areas in the outer color circle. A yellow cast, for example, is removed by a yellow filter alone, while a yellow-green cast requires a filter combination of approximately 70 % yellow and 30 % cyan filters; a blue cast is removed by 50 % magenta and 50 % cyan filters.

These examples may suffice to show the universal and versatile applications of the color circle and its importance to a proper understanding of the Agfacolor process. (Fig. 45.)

The technique of Agfacolor

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E. The material

As has been remarked in earlier chapters, the intention of Agfa in working out the Agfacolor process was to permit the processing of the material to be carried out as simply as possible, using operations as closely identical to those of monochrome photography as was possible. For the technical operation of the process, just as for monochrome photography, the following materials and accessories are required:

1. *Material for camera exposure,*
2. *Positive material on which to print,*
3. *Dark-room safelight filters,*
4. *Processing chemicals,*
   (a) for negative materials,
   (b) for positive materials.

The special accessories needed when making color prints are

5. *Agfacolor printing filters,* and

— for convenience and economy, as explained in section B above —

6. *Agfacolor copying aids.*

In obtaining supplies, it is important to be certain that they are manufactured by Agfa, either in the Wolfen or Leverkusen factories. As has been explained above, firms outside Germany are interested in the process, and now that it is generally available it is possible that materials and accessories made by other firms may come on the market. Although it may eventually be possible that films from one firm can be printed on papers from any other — as in monochrome photography — this cannot be done at present with certain success. It will be appreciated therefore, that it is essential to use throughout the material and accessories made entirely by the original designer of the process, and not to use products from different firms indiscriminately. For this reason, it is important to standardise on the Agfa products, which (with the exception of the negative films) are all clearly labelled with the trademark shown in fig. 46, consisting

of the name of the process surmounted by a design of colored circles showing the subtractive primaries.

Material for camera exposure

1. Material for camera exposure.

This is delivered in two different forms which differ greatly in their qualities —

(a) *Agfacolor Reversal film*
(b) *Agfacolor Negative film.*

Both of these materials are multi-layer color films on safety base, as described generally in section A above. All films are marked with the latest date on which they should be processed, and if allowed to over-run this date cannot be expected to give good-quality results, so that when purchasing film it is important to examine the date on the carton. In detail, the two types of material have the following qualities:

Agfacolor Reversal film

(a) *Agfacolor Reversal film.* This is made in two types: *Type T* being suitable for daylight exposures, and *Type K* for exposures in artificial light. The sensitivity of the film is marked on their containers. At present, it corresponds to a monochrome film speed of 13—16 Weston (13/10° DIN) in the case of T and K Reversal Films from Wolfen, 16—20 Weston (15/10° DIN) for Leverkusen T- and K-films. The material is available in miniature and Karat cassettes, 120, 620, and 127 spools for rollfilm cameras, as cut film in the usual photographic sizes, and as sub-standard 8 mm and 16 mm cine-film. The emulsion batch numbers of the individual films are punched on the tapered part of 35 mm films, and on the end of rollfilms. Also, miniature and rollfilms have their emulsion batch numbers printed next to the numbers of their individual frames along one edge of the film strip. All exposed films, with the exception of cut films, should be sent to one of the processing stations authorized by Agfa for reversal development, where the material is processed directly into color transparencies ready for projection. Since 1953, cut films may be developed by the user himself. For this purpose, the required chemicals and directions for their use are supplied by Agfa, Leverkusen.

Copy transparencies may be obtained from transparencies by way of the Agfacolor Reversal Copying Film. Processing of this kind is undertaken exclusively by the above-mentioned processing stations. For the time being, color prints from color transparencies can only be made by means of an additional grey mask to the transparency and a color internegative (cf. Chapt. H.). It is of course possible to

Fig. 46
The Agfacolor Trademark

produce black-and-white prints by means of monochrome negatives on panchromatic material and subsequent printing or enlarging on positive film or paper.

Agfacolor Negative film

(b) *Agfacolor Negative film* is a highly-sensitive multi-layer film designed to produce negative images in complementary colors. Two types are available: *Type T* for use in daylight or light of similar quality, and *Type K* for use in incandescent electric light*. (See also page 65). This material is available in 35-mm miniature camera cartridges, Karat cartridges (12 exposures), as 120, 620 and 127 roll-film and out film of the usual sizes. The emulsion batch numbers of

* The Agfa Wolfen factory formerly designated these types as "B" and "G" respectively: this is still done for the 35-mm cinema films they deliver, but all amateur material is denoted as above by "T" and "K".

the individual films are punched on the tapered part of the 35 mm film, and on the end in the case of rollfilms. Also, miniature and rollfilms have their emulsion batch numbers printed next to the numbers of their individual frames along one edge of the film strip. When the emulsion number is read correctly, the emulsion side of the film faces the operator. In the flat films, the usual notch is provided on one of the shorter edges: when this notch is at the top right-hand corner of the film, the emulsion side faces the operator. For better distinction Type T film has one notch and Type K film two notches.

The effective sensitivity is marked on individual film packages and lies between 8 and 10 Weston (13/10° and 14/10° DIN) for the daylight film, and to 16—20 Weston (16/10° DIN) for the artifical light film. Halation is prevented by coating the back of the celluloid base with a green-dyed layer in the normal manner. After exposure, the film may either be sent to an authorised Agfacolor processing plant for finishing, or it may be developed and printed by the user. (See under section F). Special Agfacolor processing chemicals are required, and these are available in powder form — from which the solutions are made up as and when required — from the Agfa factory in Leverkusen.

Positive material on which to print

2. Positive material on which to print.

Agfacolor positive material is a multi-layer material like the negative, and its general qualities are described in earlier sections. Three types are available:

a) Agfacolor Reversal Coyping Film } for the production of
b) Agfacolor Positive Film } color transparencies
c) Agfacolor Paper

Agfacolor Reversal Copying Film

a) *Agfacolor Reversal Copying Film* is designed for the production of copy transparencies from original transparencies. It is supplied exclusively to the processing stations authorized by Agfa; they are the sole producers of these copy transparencies.

Agfacolor Positive film

b) *Agfacolor Positive film* is intended for the printing of all types of color transparencies from Agfacolor negatives in complementariy colors, and is available as cinema film (35-mm gauge), with the usual perforations, in lengths of 10 and 25 metres without cores, and in lengths of 50 metres on 2" diameter plastic core. It is also available in unperforated widths of 61.5 mm (2.34") and 15 metre lengths (on 20-mm paper core) and as a flat film in all the usual photographic standard sizes in packets of 10 and 100 sheets. Its sensitivity is the same as that of the well-known Agfa Positive (monochrome) film and about twice that of Agfacolor Paper. Since it

is sensitive to all colors it must be handled in the dark-room in the light of a suitable filter (Agfa No. 166). The material is anti-halation backed, and may be eihter processed by authorised Agfa plants or else finished by the user. (See section F.) The result is a transparent positive in natural colors.

c) *Agfacolor Paper* is designed for making color prints and enlargements on paper from Agfacolor negatives in complementary colors. Its sensitivity is thus panchromatic in nature, and the general sensitivity is similar to that of the corresponding Agfa Brovira Papers. While at first Agfacolor Paper was available in one (normal) grade only (code number CN 111), a second, hard, grade, has been on the market since 1952 (code number CH 111). Both papers are supplied on a doubleweight base with a glossy finish only, in quantities of 10, 20, and 100 sheets in the normal paper sizes from 6.5×6.5 cm ($2^3/_4 \times 2^3/_4$") upwards. Because of the panchromatic sensitivity, the paper must only be handled in the darkroom in the light of the No. 166 Agfa safelight filter.

Agfacolor Paper

Any normal printing box or enlarger may be used for the printing process, although these should be capable of conversion to take the Agfacolor printing filters (q. v.), and the paper is either processed by authorised Agfa plants or else may be finished by the user as described in section F. The necessary chemicals for this are available in powder form, from the Agfa Leverkusen factory.

3. Agfacolor safelight filters.

Agfacolor Safelight Filters

Different safelight filters are required in the dark-room for the two Agfacolor materials — negative and positive. The high sensitivity of Agfacolor negative to all the visible spectrum necessitates the use of a very dim green light, which is provided by the No. 170 Agfa safelight filter with a 15-watt lamp and a minimum distance of 75 cm (30 inches) between the lamp and the work bench. Even with this light it is unwise to expose the film too long, so that it is really better to work in complete darkness, as is always recommended with panchromatic materials of high sensitivity. On no account should any other safelight filter than the No. 170 Agfa be used with this material.

When working Agfacolor positive material, the No. 166 Agfa safelight filter is required, again with a 15-watt lamp and a minimum distance of 75 cm (30 inches) between lamp and working plane. The light given by this filter is olive-green, but a good deal brighter than that from the No. 170 safelight, so that in spite of the panchromatic sensitising of Agfacolor positive material a sufficient amount of light for convenience in working can be provided.

Agfa dark-room safelight filters are made in the usual size of 16×21 cm (8¼×6¼") for wall lamps, and in squares of 24.5 cm (9¾") and 29.5 cm (11½") side for other lamp types.

Agfacolor processing chemicals

4. Agfacolor processing chemicals.

As the Agfacolor materials supplied vary with the purpose for which they are designed, it is necessary to use different processing chemicals. Suitable chemicals have been found, formulae determined, and tests made in order that deliveries may be reliable. On no account can ordinary baths as used in the monochrome photographic process be used for Agfacolor material, and reliable and consistent results can only be expected with the special products delivered by Agfa. The chemical substances required differ slightly for

a) Agfacolor Reversal Cut Film
b) Agfacolor Negative Film
c) Agfacolor Positive Film
d) Agfacolor Paper.

so that the solutions are not interchangeable. Apart from the special color-developing chemicals, it is desirable to have available

(d) Agfa Agepon wetting agent,
(e) Agfa Film Lacquer, and
(f) Agfacolor Anti-fading Solution.

Processing chemicals for Agfacolor Reversal Cut Film

a) *Processing chemicals for Agfacolor Reversal Cut Film.*

After exposure, the Agfacolor Reversal Cut Film is developed to a monochrome negative in the first developer. After a thorough intermediate rinse, the residual undeveloped silver bromide is submitted to a second exposure, and developed to a color positive in the subsequent color developer for Agfacolor Reversal Film. A bleaching bath follows this color development in order to convert the silver formed during both developments into soluble silver salts, which are dissolved and removed in the following fixing bath. The hardening bath for Agfacolor Reversal Film represents the last processing step. In accordance with these details, the following five processing solutions are supplied for the processing of Agfacolor Reversal Cut Films: —

1) First Developer for Agfacolor Reversal Film
2) Color Developer for Agfacolor Reversal Film
3) Bleaching Bath for Agfacolor Reversal Film
4) Fixing Bath for Agfacolor Reversal Film
5) Hardening Bath for Agfacolor Reversal Film.

They are supplied in powder form to make 1 L (35 fl. oz.) or 10 L (2¼ gallons) of working solutions respectively. To prepare these solutions, the following directions, which are also enclosed with the individual packages, should be followed.

First Developer for Agfacolor Reversal Film

First Developer for Agfacolor Reversal film

Each package consists of two parts, A and B. (Part A of the 10 L package consists in turn of two identical bags each containing developer substance aufficient for 5 L solutions.)

First dissolve contents of part B in 800 cc (28 fl. oz.) of water (or 8 L, 1¾ gallons) respectively) at 85—95 degs. F. The entire contents of part A should then be stirred in and the volume brought up to a total of 1 L (35 fl. oz.) 10 L (2¼ gallons) respectively by the addition of water. The solution should be prepared in a clean vessel made of earthenware, glass, plastic material or flawless enamel without blemishes. For storage, well-stoppered brown glass bottles should be used. The first developer is ready for use 12 hours after it has been made up.

In order to be able to prepare a 5 L (1⅛ gallons) solution, Part A of the 10 L (2¼ gallons) package containes two identical bags of developer substance. In this case part B of the 10 L (2¼ gallons) package is dissolved in 8 L (1¾ gallons) of water and the volume made up to a total of 10 L (2¼ gallons). This solution has excellent keeping qualities in glass bottles. To make up 5 L of (1⅛ gallons) of first developer, 5 L (1⅛ gallons) of this solution are taken, and the contents of *one* bag of part A stirred in. The result is a 5 L (1⅛ gallons) solution of first developer for Agfacolor Reversal Film.

Color Developer for Agfacolor Reversal Film

Color Developer for Agfacolor Reversal Film

This package consists of 2 parts, A and B. The contents of the larger part B are dissolved *completely*, well stirring all the time, in 800 cc or 8 L (1¾ gallons) of water respectively at 85—95 degs. F. Then the contents of part A are *completely* dissolved in 100 cc. (4 fl. oz.) or 1 L (35 fl. oz.) of water respectively at 85 degs. F and slowly added to part B, stirring, and avoiding the formation of air bubbles. Finally, the solution is made up to a total volume of 1 L (35 fl. oz.) or 10 L (2¼ gallons) respectively by the addition of water. The developer is ready for use 12 hours after preparation. Part A of the 10 L (2¼ gallons) package contains 2 bags to enable 2× 5 L (1½ gallons) of developer solution to be made up.

For the 10 L (2¼ gallons) solution *both* bags of part A should be added to part B according to the directions given above.

If only 5 L (1 1/8 gallons) of the color developer are required, part B should be made up to a total volume of 8 L (1 3/4 gallons). This solution B has excellent keeping qualities in closed bottles.

To prepare 5 litres (1 1/8 gallons) of color developer, the contents of *one* pack of part A should be dissolved completely in 1 litre (35 fluid ounces) of water. This solution is then added with stirring to half of the B solution, i. e. 4 litres.

Bleaching Bath for Agfacolor Reversal Film

Bleaching Bath for Agfacolor Reversal Film

The contents of the package are dissolved in 800 cc. (32 fl. oz.) or 8 L (1 3/4 gallons) of water respectively at 85 degs. F., and the solution made up to a total volume of 1 L or 10 L (35 fl. oz or 2 1/4 gallons) respectively by the addition of water. After cooling to 65—68 degs. F the bleaching solution is ready for use.

Fixing Bath for Agfacolor Reversal Film

Fixing Bath for Agfacolor Reversal Film

The contents of the package are dissolved in 800 cc. (32 fl. oz.) or 8 L (1 3/4 gallons) of water respectively at 85 degs. F and the solution made up to a total volume of 1 L or 10 L (35 fl. oz or 2 1/4 gallons) respectively by the addition of water. After cooling to 65—68 degs. F the fixing solution is ready for use.

Hardening Bath for Agfacolor Reversal Film

Hardening Bath for Agfacolor Reversal Film

The contents of the package are stirred into 800 cc (32 fl. oz.) or 8 L (1 3/4 gallons) tap water respectively at appr. 68 degs. F (NOT hot) until dissolved. After adding water to make 1 L (35 fl. oz.) or 10 L (2 1/4 gallons) respectively the solution is ready for use.

Processing chemicals for Agfacolor Negative Film

b) Processing chemicals for Agfacolor Negative Film

Agfacolor Developer for Negative and Positive Film

Agfacolor Developer for Negative and Positive Film.

The orange-red tin as delivered contains two parts, of which that marked A contains the developing agent and that marked B the accessory chemicals. These two parts are dissolved in separate volumes of water, each of 400 cc. (16 fl. oz.) 4 L (1 gallons) or 15 litres (3 1/4 gallons) according to the size of the developer package. If it proves more convenient, packet A may be dissolved in 100 cc. (4 fl. oz.), 1 L (35 fl. oz.) or 3 litres (100 fl. oz. of water, and packet B in 700 cc. (26 fl. oz.), 7 L (1 1/2 gallons) or 30 litres (6 1/2 gallons) of water at 86° to 105° F. (30° to 40° C.) with gentle but thorough stirring. In either case, the developer is completed by slowly pouring solution A into solution B, with constant gentle stirring and avoiding the formation of air-bubbles, and by adding water to make up to

the full volume of 1 litre (35 fl. oz.), 10 L (2¼ gallons) or 35 litres (7½ gallons). The developer should be stored in tightly stoppered brown glass bottles, and must stand twelve hours before use.

Agfacolor Bleaching Bath for Negative Film

Agfacolor Bleaching Bath for Negative Film

The contents of the package are simply dissolved in either one litre (35 fl. oz.), 10 L (2¼ gallons) or else 35 litres (7½ gallons) of water, and the solution is then ready for use.

Agfacolor Fixing Bath for Negative Film

Agfacolor Fixing Bath for Negative Film

The package of negative fixing bath contains two packets marked A and B. First dissolve the contents of packet A in either one litre (35 fl. oz.), 10 L (2¼ gallons) or else 35 litres (7½ gallons) of water, and when fully dissolved add the contents of packet B. When all solids have dissolved the fixing bath is ready for use.

Regenerator for Agfacolor Developer for Negative and Positive Film.

Regenerator for Agfacolor Developer for Negative und Positive Film

This package is used to regenerate the Agfacolor negative and positive film developer during continued use in a tank. It is delivered in powder form to make up 3 litres (105 fl. oz.) of working, solution.

The contents of packets A and B are dissolved in separate volumes of water, of 1½ litres (53 fl. oz.) each. When completely dissolved, solution A is poured slowly into solution B, with constant stirring and avoiding the production of air-bubbles. The regenerator solution must be stored in tightly stoppered brown glass bottles: this method of storage is essential.

The regenerator is only suitable for adding to Agfacolor negative and positive film developer, and must never be used alone as a developing solution.

c) *Processing chemicals for Agfacolor Positive film*

Processing chemicals for Agfacolor Positive film

With the exception of the color developer, and the baths used in the processing of Agfacolor Positive Film are different from those for Agfacolor Negative Film. They are the following: —

1) Agfacolor Stop Bath for Positive film and
2) Agfacolor Bleaching-Fixing Bath for Positive film and Paper
3) Agfacolor Special After-bath for Positive film.

Instructions on how to prepare the color developer are already given on p 78. For the remaining three baths they are as follows: —

Agfacolor Stop Bath for Positive Film

Agfacolor Stop Bath for Positive Film

The package of Agfacolor Stop Bath for Positive Film consists of 2 parts. Contents of the two packages are dissolved successively in the appropriate volume of water at 85 — 100 degs. F. The bath is ready for immediate use.

Agfacolor Bleaching Fixing Bath for Positive film and Paper

Agfacolor Bleaching-Fixing Bath for Positive film and Paper

The package of Agfacolor Bleaching-Fixing Bath consists of 2 parts: — A and B. Part A is stirred well into 800 cc., 4 L, 8 L, or 28 L (32 fl. oz.) (1 gallon) (1¾ gallons) (6 gallons) of water respectively at 100-122 degs. F. Contents of part B are added to the solution, also with constant stirring. The clear solution, with has a deep brown-red color, is topped up to its final volume and cooled to 65—68 degs. F. It is ready for immediate use.

Agfacolor Special After-bath for Positive Film

Agfacolor Special After-bath for Positive Film: —

The package of Agfacolor Special After-bath for Positive Film is dissolved in the stated volume of tap-water; the bath is ready for immediate use. In exceptional cases, part quantities may be taken from this bulk package if volumes smaller than 35 L (7½ gallons) are to be made up. 70 g of the substance ar required to prepare 1 L of working solution.

The chemicals for Agfacolor Negative and Agfacolor Positive Films respectively are basically different from those to be used in the processing of Agfacolor Paper. They must on no account be interchanged.

Regneration of Bleaching-fixing Bath for Positive film and Paper

Regeneration of Bleaching-fixing Bath for Positive film and Paper

During its use, the bleaching-fixing bath may show changes in two directions: —

1) a decrease in its acid content
2) a decrease of the concentration of its chemicals due to water carried into the solution.

In addition to the above-mentioned concentration, its acidity is extremely important for the proper functioning of the bleaching-fixing bath. The bleaching-fixing bath indicator paper is supplied to check the acid level, and the bleaching-fixing bath regenerator for the adjustment to its correct value. The contents of the standard bleaching-fixing bath packet are used to replace the used-up chemicals. To control the concentration of the chemicals, the bleaching-fixing bath testing rod is employed.

The bleaching - fixing bath indicator paper changes its color according tho the degree of acidity. The packet of bleaching-fixing bath regenerator to establish the correct acid level contains 150 g of substance. It is added in small quantities to the bleaching-fixing bath as required, and is sufficient for 50 L (11¼ gallons) of used bleaching-fixing bath. The working procedure with bleaching-fixing bath indicator paper, testing rod, and regenerator is dealt with in more detail in the chapter on processing.

d) *Processing chemicals for Agfacolor Paper*

Processing chemicals for Agfacolor Paper

The chemicals used for processing Agfacolor Paper, and the formulare in which they are used, are very different from those required for Agfacolor Negative or Positive film. The process follows the ordinary sequence of monochrome papers, except that a bleaching bath is used to remove the silver from the image between the stop bath and the fixing bath. Packages of chemicals for the various solutions are delivered in dry form, to make either one litre (35 fl. oz.), 5 L (1 1/8 gallons), 10 L (2 1/4 gallons), 50 L (11 1/4 gallons), as follows.

1. Agfacolor Paper Developer
2. Agfacolor Paper Stop Bath
3. Agfacolor Paper Bleaching Bath, and
4. Agfacolor Paper Fixing Bath

In the course of recent progress, Agfa succeeded in a further simplification of Agfacolor Paper processing, giving the choice of a second and shorter working sequence. It consists of the following three baths only: —

1) Agfacolor Paper Developer
2) Agfacolor Bleaching-Fixing Bath for Positive film and Paper and
3) Agfacolor Paper Hardening Bath

Details of these various processing steps will be given under Part "G", Processing. Instructions for the preparation of these baths are found on the individual packages as follows: —

Agfacolor Paper Developer

Agfacolor Paper Developer

The contents of part A are first dissolved in either 100 cc. (4 fl. oz.) or else 1 litre (35 fl. oz.) and the contents of packet B separately in a further 700 cc. (24 fl. oz.) or else 7 litres (1 1/2 gallons) of water at 30° C. (86° F.). When all solids have dissolved, solution A is poured slowly into solution B, with gentle stirring to avoid the formation of air-bubbles, and the mixed solution is made up to the full volume of 1 litre (35 fl. oz.) or else 10 litres (2 1/4 gallons) with cold water. After standing for twelve hours the developer is ready for use.

Agfacolor Paper Stop Bath

Agfacolor Paper Stop Bath

The package contains two smaller packets marked A and B. The contents of these are dissolved successively (in either order) in either 1 litre (35 fl. oz.) or else 10 litres (2 1/4 gallons) of water, and when all solids have dissolved the solution is ready for use.

Agfacolor Paper Bleaching Bath

Agfacolor Paper Bleaching Bath

The contents of the package are simply dissolved in either 1 litre (35 fl. oz.) or else 10 litres (2¼ gallons) of water, and the bath is then ready for use.

Agfacolor Paper Fixing Beath

Agfacolor Paper Fixing Bath

The package contains two smaller packets marked A and B. These are dissolved successively (in either order) in 1 litre (35 fl. oz.) or else 10 litres (2¼ gallons) of water, and when all solids have dissolved the solution is ready for use.

Agfacolor-Bleaching-Fixing Bath

Agfacolor Bleaching-Fixing Bath for Positive film and Paper (cf. p. 80)

Agfacolor Paper Hardening Bath

Agfacolor Paper Hardening Bath

The contents of the package are stirred into 800 cc (32 fl. oz.) or 8 L (1¾ gallons) tap water respectively at appr. 68 degs. F (NOT hot) until dissolved. After adding water to make 1 L (35 fl. oz.) or 10 L (2¼ gallons) respectively the solution is ready for use.

Regenerator for Agfacolor Paper Developer

Regenerator for Agfacolor Paper Developer.

The regenerator described below is only designed for addition to Agfacolor positive developer, and must never be used as a developer alone. It is delivered in tropical packing to make a volume of 3 litres (105 fl. oz.), and the method of using the regenerator for keeping the qualities of the tank constant are given on page 102. By using the regenerator, the life of the developer is prolonged and its use made more economical.

The regenerator is made up as follows:

The contents of the part A are dissolved in 1½ litres of water (52 fl. oz.) and the contents of part B in a separate 1½ litres (52 fl. oz.) of water at 30° C. (85° F.) When all solids have dissolved, solution A is slowly poured into solution B with constant stirring and avoiding the production of air-bubbles. It is essential to store the regenerator solution in tightly stoppered brown glass bottles.

Agfa Agepon Wetting Agent

(c) *Agfa Agepon Wetting Agent*

This chemical is a simple means of preventing water drops from forming during the drying of Agfacolor negative and positive materials. It is delivered in bottles of 1 litre (35 fl. oz.), and is diluted with 200 volumes of water and used as a final bath after the washing has been completed. After this treatment it is unnecessary to dry down the films and paper prints with a leather, which is useful since the emulsion of Agfacolor materials is unhardened and sensitive to mechanical abraison. The use of Agepon wetting agent is therefore recommended as a standard bath just before drying.

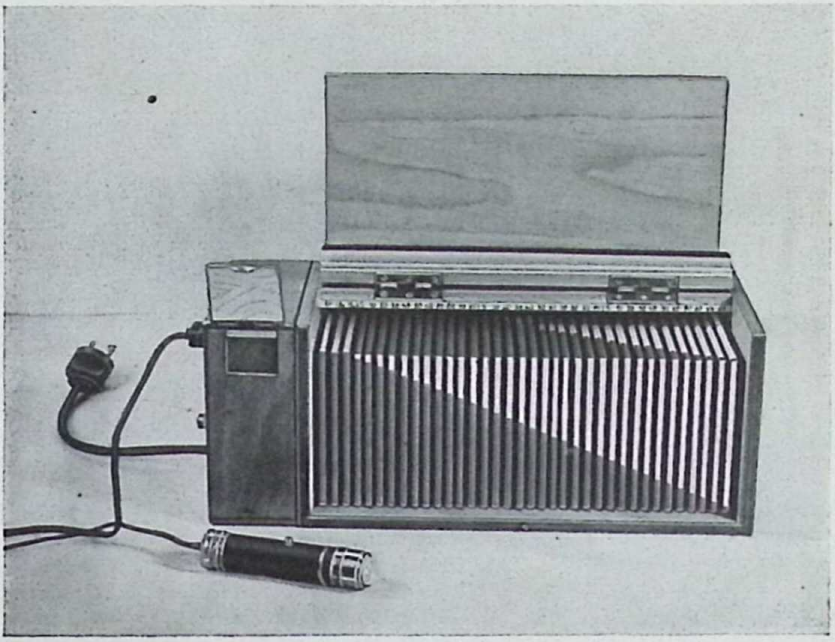


Fig. 47
Agfacolor Printing Filters and Mosaic filters in working case

(f) *Agfa Film Lacquer*

Agfa Film Lacquer

Where unhardened emulsions must be used, as in Agfacolor films, it is very difficult to avoid accidental abrasion marks and fingerprints. This may largely be avoided by covering the sensitive emulsion surface with Agfa Film Lacquer, provided that this is applied immediately after processing. Films which are already abraded are also much improved by treatment with the lacquer.

Agfa Film Lacquer is delivered in bottles containing 1 litre (35 fl. oz.). It is inflammable, and must thus be kept away from open flames, while the bottle should be tightly stoppered after use to prevent evaporation. The lacquer is used undiluted.

(g) *Agfacolor Anti-fading Agent*

Agfacolor Anti-fading Agent

The Agfacolor Auti-fading Agent serves to improve the resistance to light and the keeping qualities of Agfacolor pictures. It is sold to the user in powder form to give 1 and 10 L (35 fl. oz. or $2^1/_4$ gallons) of working solution. Every Agfacolor picture should be treated in this

protective solution as a matter of routine. The keeping qualities of Agfacolor transparencies, too, are improved by the desensitizing agent. The application of the solution is described under G., page 145.

Agfacolor Printig Filters

5. Agfacolor Printing Filters

The purpose of these printing filters is both to remove a general color-cast from Agfacolor prints and to alter the color reproduction in some desired manner. They are square glass sheets in the three colors yellow, magenta and cyan, and are made in a range of color densities of 5, 10, 20, ... to 99 units*. A complete set of printing filters thus includes $3 \times 11 = 33$ separate filters, which are made in the sizes 7×7 cm ($2^3/_4$" square) for miniature negatives, 12×12 cm ($4^3/_4$" square) for negatives up to $3^1/_2 \times 2^1/_2$" (6×9 cm), 23×23 cm (9" square) for negatives up to 7×5" (13×18 cm), and 30×30 cm ($11^3/_4$" square) for larger negatives. The color and density of each filter is indicated by a code of six figures, of which the first two indicate density of yellow, the second two density of magenta, and the final two density of cyan. A yellow filter of 20 units density is thus coded as 20 00 00, a magenta 50-unit filter as 00 50 00, and the highest cyan densitiy as 00 00 99. The use of this code allows filter combinations to be accurately and simply indicated and recorded: if, for example, a particular Agfacolor negative required 20 units of yellow and 40 units of magenta for correction, the combination is recorded as 20 40 00. The 5-unit filter in each color is intended to be used for fine correction by addition to any other filter of the same color. Agfacolor Printing Filters are delivered in a special case containing the complete set, with an illuminating device to identify them in the dark-room, or else as single filters. (See fig. 47.)

The working case holding the Agfacolor Printing and Mosaic filters is arranged to hold the printing filters vertical in a convenient row from left to right. The selection of the wanted filter is simplified by an illuminating device operated by a push-button switch, and the light used is "safe" for Agfacolor Paper so that accidental fogging cannot occur. Each printing filter is provided with edges divided into white and black sections: the denser the filter, the longer the white section is in proportion to the black. This eases the selection of the correct filters, and also shows up immediately when they get out of order. (See fig. 47.)

* The final number of color units is 100, but it is marked 99 in order that a six-figure coding may be used.

The working case also contains a small lamp with a cover which is used for writing, and if desired a hand lamp can also be delivered as an extra. Both lamps are fitted with safelight filters and are "safe" for Agfacolor Paper.

6. *Agfacolor Printing Aids*

Agfacolor Printing Aids

a) Agfacolor Mosaic Filters.

The series of Agfacolor Mosaic Filters has been designed to simplify the process of determining the correct filter combination for printing "neutral" colored copies. They include the colors yellow, magenta and cyan in their three possible combinations of yellow/magenta, yellow/cyan and magenta/cyan. Each of these combinations is represented by densities of 0, 20, 40, 60, 80 and 99 units in each of the two colors (see diagram on page 127 and fig. 30, Plates VIII and IX), and each group of 36 color fields is repeated eight times in each of the three filters.

The Agfacolor Mosaic filters are made in the size 6.5 × 12 cm ($4^3/_4 \times 2^1/_2$"), and are delivered either as glass filters for use in enlarging or on a flexible base for the printing box. In enlarging, the mosaic filter is placed on the easel, on top of the Agfacolor Paper, while in contact printing it is placed between the negative and the paper: in either case it is essential to place it in such a position that the important parts of the picture are covered by the 36 filter fields provided. Each mosaic filter has one field with no filter colors: this shows the reproduction given without any printing filter and also indicates the exposure necessary in a general manner. The filters are delivered either as complete sets of three, or else as single mosaic filters, and with them is delivered a transparent mask with eight square holes so spaced that when laid on the print the mask allows eight small fields produced by the same filter combination to be seen. By this means, the choice of the correct filter combination for the final print is made much simpler.

b) Colorax
c) Colormeister
d) E. K. Strip Printer
e) Hexagonal Filter
f) Agfacolor Comparator

The printing aids listed under b) to f) are discribed in Part B, p. 48.

F. Agfacolor in the camera

One of the most difficult tasks in photography is the recording and reproduction in color of the world around us. There are, in fact, few fields of artistic endeavour in which the gap between true art and mere sentimentalism is so dangerously narrow.

Not every color print succeeds in being colorful: a bed of flowers some distance from the Agfacolor camera merely shows as a set of colored dots, and it is only when the flowers are shown as two or three blooms alone that their color and grace really manifests itself. Equally the careful choice of background colors and the general color composition of the scene is capable of changing the print from a mere reproduction into a creative work of genuine artistic value. The illustrations in this book have been chosen to indicate the large number of different fields in which consideration of these points is essential.

The photographer, however, must always keep one eye firmly on his technical rules, be he never so artistically minded, so that the following points in exposure technique on Agfacolor material whould be studied carefully.

Agfacolor Reversal Film Type T

(a) *Agfacolor Reversal Film Type T (for use in light of daylight quality)* (cf. p. 184).

This film requires the same camera technique as does Agfacolor Negative Film Type T below. Two points merit special attention in connection with reversal Film:

1) Like all reversal films, it has an exposure latitude which is reduced considerably compared with that of a negative material.

2) In the final transparency, over-exposed pictures appear very light, under-exposed pictures dark. This distinction from negative films, rendered very dark by over-exposure and very thin and light by under-exposure, sometimes leads to faulty interpretation.

The speeds of the reversal films correspond to the information given on the packages. If for color films especially for color reversal films the use of an exposure meter is recommended. The exposure

meter has to be adjusted to the speed of the film used. Standardization of the exposure meter is recommended in use with the camera and the film employed (cf. p. 89).

Agfacolor Negative Film Type T

(b) *Agfacolor Negative Film Type T (for use in light of daylight quality).*

This is a highly sensitive panchromatic multi-layer film intended to produce negatives in complementary colors. Its color sensitivity is adjusted to suit average daylight with a color temperature of 5500° K*. Since it is a negative material, the exposure latitude is materially greater than Agfacolor reversal material.

Since all colors are most fully saturated in full sunlight, the best results on Agfacolor are obtained when the sun is shining clearly, and is behind the camera. In dull weather the colors lose some of their brilliance, and will be reproduced objectively by Agfacolor film, but provided that exposure is accurate it is possible to get highly effective Agfacolor exposures under a cloudy sky or even when it is raining. The exposure latitude of the negative process also permits side and back-light to be used if so desired (but the exposure must be doubled as compared with front light) with satisfactory results. As a general rule, therefore, Agfacolor Negative film may be used in all circumstances where an ordinary monochrome panchromatic film could be used.

It must be repeated here that the color reproduction is objective, and that colored reflections will appear colored in spite of the fact that our eyes disregard them. Under green trees, for example, the light is much more green than our eyes will admit, and this green light will appear in its full color in the print. Similarly, a portrait taken under a red garden sunshade will be strongly red in the print, although the untrained eye will fail to notice the fact when observing the original subject.

Particularly with color films, the old rule that the closer to the subject, the better, still retains its importance. Agfacolor exposures — particularly landscape exposures taken from a distance — lose their interest by showing only a series of tiny areas of color. The larger the area in the image covered by a given color, the more effective and strong the color will appear to be. In landscape work it is thus important to provide some foreground interest in the shape of a person, a tree or other object which will provide the necessary close color and enliven the scene. It is specially important that this foreground presents warm tones of color, for the eye appreciates

* See the table at the end of this book which gives the color temperatures of various types of light sources.

these more than cold colors, and the contrast against the background is made more striking.

Turning to the mechanics of exposure, Agfacolor films is loaded into the camera in just the same way as any other kind of film. Agfacolor film here must be used with the same precautions as monochrome material, and where the lens aperture available is small, pains must be taken that the material is given adequate camera exposure. The camera may be of any kind at all — even box cameras are quite suitable — but obviously the most satisfactory results appear where a good quality lens with adequate color correction is available. Bloomed lenses are also desirable (i. e., those coated on each glass-air surface with an anti-scatter layer) but not absolutely indispensable. When loading the film, direct sunlight should not reach it, so that if no shade is near, the camera and film should at least be shaded by the body of the photographer during the loading process. After exposure, and during unloading, the same care is necessary, and the film should at once be rewrapped in its original light-proof paper when it has been removed from the camera. These precautions will prevent fogged edges. The red window of the camera through which exposure numbers are seen should also not be exposed to direct sunlight for more than brief intervals: if this is not done, then there is a risk of a cyan image of the window appearing on the negative later, which will print to red in the color positive.

Exposure should be determined, if possible, by an exposure meter (e. g. the Agfa Lucimeter) or by reference to the Agfa Exposure Table.

The individual values for Agfacolor Films in the various speed rating systems may be obtained from the following table (See the table on next side):

Exposure meter Standardization

Since exposure meters and camera shutters, as well as lens diaphragms contain a certain margin of error, it is recommended to standardize the exposure meter in use with the camera and the film employed. The best procedure is to chose the exposure time indicated by the exposuremeter for the film speed stated, and to make two further exposures at twice and half this exposure time at the same stop, or, alternatively, at the next larger and next smaller stop at the same exposure time. Based on the appearance of the developed exposures, the speed-rating of the film on the exposure meter is determined as follows for all future exposures. If the correctly exposed picture corresponds to the speed indicated on the film container, this speed will be valid. Should the picture taken at half the exposure time be the correct one in contradiction to the exposure meter reading, the film speed in all future cases should be rated

Speed rating Systems

DIN degrees	A S A Expos. Ind.	General Electr.	Weston No.	Europ. Scheiner degrees	Respective exposure time
9/10	5	—	4,0	19	10
10/10	6	8	5,0	20	8
11/10	8	10	6,4	21	6,4
12/10	10	13	8	22	5
13/10	12	16	10	23	4
14/10	16	20	13	24	3,2
15/10	20	25	16	25	2,5
16/10	25	32	20	26	2,0
17/10	32	40	25	27	1,6
18/10	40	50	32	28	1,2
19/10	50	64	40	29	1,0
20/10	64	80	50	30	0,8
21/10	80	100	64	31	0,64
22/10	100	125	80	32	0,50

twice on the exposure meter. If the picture at twice the exposure time gives the best result the exposure meter indication notwithstanding, all future exposures based on this meter should be assessed at a film speed which is half that stated on the film container.

Exposure table for Negative Film

	Sun in clear sky	Lightly veiled sun	Partly overcast	Overcast, or under trees when clear sun is shinning
Beaches, mountains and snow scenes	f/11	f/8	f/5,6	f/4
Open landscapes, sunny streets, and open squares	f/8	f/5,6	f/4	f/2,8
People in the open, landscapes with foreground, and street scenes*	f/5,6	f/4	f/2,8	f/2
People in the shade or in gardens	f/4	f/2,8	f/2	f/2

* This standard lens aperture will give satisfactory results in most cases when using Agfacolor Negative Type T. If the lens aperture scale does not reach wide enough apertures, then the next smaller aperture to that on the table may be used, and the shutter speed doubled to 1/25th second. (If the shutter speed is lessened similarly, the aperture must be widened to compensate for the shorter exposure time.) Between noon and 2 p. m. in summer, the high sun causes hard and deep shadows under the nose and in the eye-sockets of portraits. This type of lighting should therefore be avoided for portrait exposures.

If no exposure meter or exposure table is at hand, the abbreviated table on page 90 will usually give satisfactory results with a shutter speed of 1/50th of a second.

For all exposures between 10 a. m. and 4 p. m. in the months of May to August inclusive, the shutter speed should be set to 1/50th second and the lens aperture in the table below used. (For other months of the year or hours of the day, the exposure time should be doubled or the next larger lens aperture used.)

Arc lamps

Artifical light of daylight quality

Where studio exposures are made with the light of white flame arc lamps, the daylight type of film (T) should be chosen, and not the artificial light film (type K). The same is true where the Osram HNT tubular fluorescent lamps are used, and for electronic flash tubes. Under these conditions the optimum exposure conditions should be determined with an exposure meter or by a luxmeter (see under d) below. The guide numbers applying to Agfacolor Film when electronic flash or flash-bulbs are used are found in the tables at the end of this book.

Mixed light

Exposure Filters

Mixtures of light with different color temperatures should never be used with color material: particularly where daylight and incandescent light are mixed, the result is unpleasant variations in colors over the picture area. (See fig. 48, Plate XVIII, and fig. 50, page 94). Nor should a camera filter be used under any conditions, for what it does may equally well be done by the printing filter later on. The only filters permitted are colorless polarizing filters to eliminate undesirable reflections, and colorles ultra violet (U. V.)-absorption filters to suppress excess U. V. radiation during exposures at high altitudes (e. g. Agfa filter K 29 c).

Polarizing Filters

Crystal clear (not tinted) polarizing filters are also most useful for better reproduction of white clouds in blue sky and clear distances. (Elimination of polarized parts of the sky-light.)

The polarizing effect can be observed by looking through the filter and turning it in either direction to the optimum. In such position the 0 point of the filter will point to the sun when placed on the lens. The exposure should be increased three to four times.

The elimination of polarised sky-light may also be used for night-effects taken in day-light. In this case the picture has to be well underexposed. (The exposure-time with polarizing filter must be the same as for correct exposure without filter.) Under such conditions the underexposed picture will show a deep-dark sky and blackish colors similar to the night-effect.

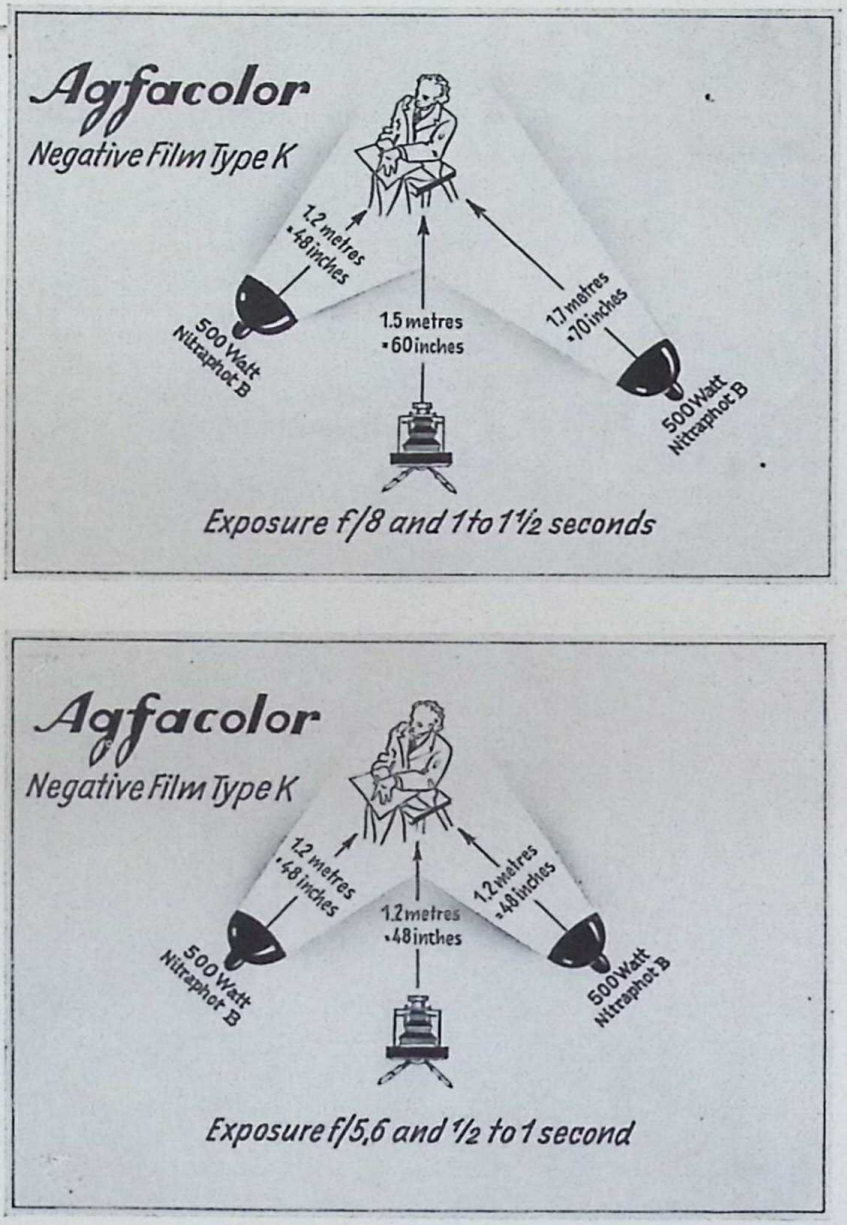


Fig. 48
Guide to exposures at home in artificial light

In either case the position of the sun must be at right angle to the optical axis of the lens and the O-point directed to the sun.

For all exposures in sunlight, a lens hood is important, even if the sun is behind the camera. *Lens hood*

Where exposures are made in which the best possible color reproduction is considered a primary essential, as with advertising work and the like, it is desirable to include in the scene exposed a scale of grey tones or else a standard color chart which includes greys. This should not be placed in an important area of the scene, but at the side, and its examination will greatly simplify the choice of a printing filter to give optimum color reproduction. As has been said above, if a grey scale is properly reproduced as grey, then the other colors have the best reproduction of which the process is capable. A suitable neutral grey scale is available from Agfa. *Grey scale*

(c) *Agfacolor Reversal Film Type K (for use in artificial light)* *Agfacolor Reversal Film Type K*

The qualities of this film are identical with those of the corresponding negative material, except that the smaller exposure latitude due to the reversal process must be taken into account.

Agfacolor Reversal Film K at present corresponds to a speed of 13—16 Weston (15/10° DIN). The same rules apply to the arrangement of nitraphot lamps as with the use of monochrome films. Special points to consider are background illumination and the avoidance of colored reflections from wallpaper are especially to be considered.

Exposure hints with Nitraphot lamps type B, 500 W in aluminium reflectors at f/4.

1 lamp at distance			
2'6"	3'3"	5'	6'6" from subject
Exposure time			
1/10 sec.	1/5 sec.	1/2 sec.	1 sec.
2 lamps at a distance			
2'6"/4'2"	3'3"/5'		5'/8' from subject
Exposure time			
1/10 sec.	1/5 sec.		1/2 sec.

If yellow flashbulbs or flash powder are used, the appropriate directions should be followed. It should be noted that with half the speed for which the flash conditions are valid the next-larger stop, i. e. the next-smaller stop-number should be employed. At one fourth of the speed the aperture should be 2 stopnumbers larger or the distance of the flash should be halved. The use of plain flashbulbs *Flashbulbs*

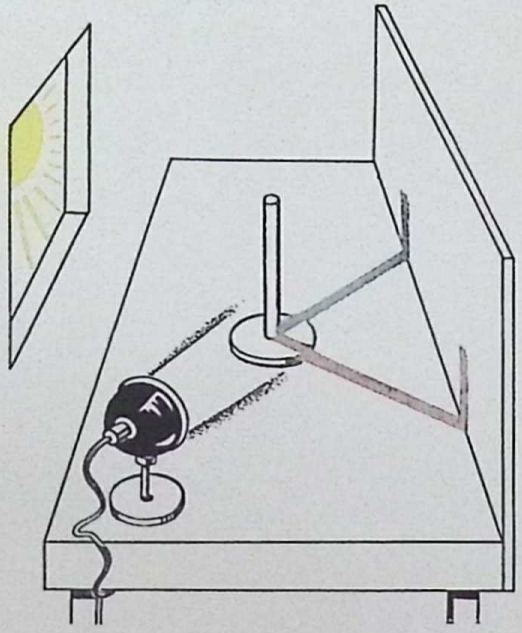


Fig. 49
The effects of mixed light quality.
Where two light sources of different color quality are used, the shadows will have different colors.

is not recommended. Agfacolor Reversal Film K is not suitable for electronic flash.

The use of taking filters is in all instances unnecessary and undesirable.

Agfacolor Negative Film K

a) *Agfacolor Negative Film K (for use in artificial light)*

Agfacolor Negative Film K at present corresponds to a speed of 16—20 Weston (16/10⁰ Din).

This film is adjusted in color sensitivity to suit light with a color temperature of 3200⁰ K, which is that given by the Nitraphot B type of incandescent lamps, Photolamp or Photopearl.* Other types of incandescent lamps may, however, be used satisfactorily, since slight differences in the color temperature of the source may be compensated by the choice of a suitable printing filter.

* See the table the end of this book which gives the color temperature of the various types of light sources.

Exposure table for "K"-Film

Exposure table for "K"-Film

Stop / Lux	4,5	5,6	8	11	16	22	32	
3000	1/10	1/5	1/2	1	2	4	8	
2000	1/5	1/2	1	2	4	8	16	seconds
1000	1/2	1	2	4	8	16	32	
500	1	2	4	8	16	32	1	
250	2	4	8	16	32	1	2	minuts
100	5	10	20	40	1 1/4	2 1/2	5	
50	10	20	40	1 1/4	2 1/2	5	10	
25	20	40	1 1/4	2 1/2	5	10	20	

(Cf. pp. 38 and 84 ff.) The same is true of flash-powder and of clear flash-bulbs, but these types of source must used alone, and not in combination with incandescent lamps.

For illumination, the entire area to be exposed should be evenly lit with what the film people call a key light: the illumination level should not be guessed or estimated visually, but measured with an illumination meter or luxmeter. A lux measurement is taken by pointing the luxmeter in the direction of the camera lens from the location of the subject, i. e. the light incident upon the subject is measured. The following table gives exposure times and stops in relation to the given lux numbers. The times indicated may vary somewhat with the make of luxmeter. It is, therefore recommended to standardize the luxmeter used with the given camera and film once and for all in much the same way as the exposure meter, and to adjust the values if necessary.

Luxmeter

On the key light as a basis the required lighting effects may be superimposed. Until the behaviour of the material in strong lighting contrast has been learned, it is undesirable to drive lighting effects too hard, since plastic effect is enhanced by the colors and will prove much more strong than in a monochrome print under identical lighting. By keeping to these conditions, well-lit portrait studies on Agfacolor negative film can be made with two or three Nitraphot type lamps.

It is essential in studio work to use an adequate lens hood on the camera, in order to avoid trouble from stray light outside the area of the subject.

Lens hood

Mixing light

It is also very important to avoid mixing light of varying color temperatures. Daylight and half-watt light, flashlight and half-watt light, half-watt light and photofloods or similar lamps; all these are mixtures of color temperatures and will produce differentially colored light tones and shadows as has already been explained. It is only where the variation in color temperature between two sources is quite small that such differential effects as these will pass unnoticed.

As a general guide to exposures at home with Agfacolor Negative Film Type K, it may further be said that in ordinary room illumination of some 500 watts (this includes ceiling lights and other lamps) a lens aperture of f/4 and an exposure time of half a second to three seconds will give satisfactory results. The exposure time here will depend on the furnishings of the room: light-colored walls and carpets will allow the shorter times to be used, while dark-colored rooms and furniture will make the longer ones necessary. In cases of doubt, the exposure is naturally increased in order to avoid risks of under-exposure.

Rules for taking pictures

These technical points naturally do not complete the education of a photographer in studio work on Agfacolor material, for the whole of aesthetics must still be considered. It is here that understanding can make or mar the result, and where the master-hand shows itself. In general, one may either produce color prints in which little color contrast is present, and in which the lighting has been arranged to show up the subject in the desired manner, or else one may go to use highly contrasting — or even complementary — colors and rely to a relatively little extent on lighting as such. An example of the latter technique would be the use of a green background to accentuate reds in the foreground, and between the two extremes lies an infinite variety of possibilities in which personal preference may be allowed to range freely. As far as possible, however, it is desirable to have warm tones in the foreground, since the eye finds this more attractive than having them in the background. Colder tones should thus be kept in the background or lie in the shadows of the foreground.

In making portraits on Agfacolor negative material, it is important to bear in mind that retouching on the scale normally used with monochrome material is impossible. The most that can be done is to lighten the shadows relative to the rest of the image and to spot out blemishes. Any attempt to retouch the negative with color, in order to alter the colors of the positive at that point is greatly to be deprecated, for the risk of spoiling the print is very great indeed.

In this picture, the foreground is emphasized intentionally by the red jacket. It is an attractive counterpart to the monochrome dress. The landscape is merely decoration and not the main subject. (Photo by H. Dr. Berger)

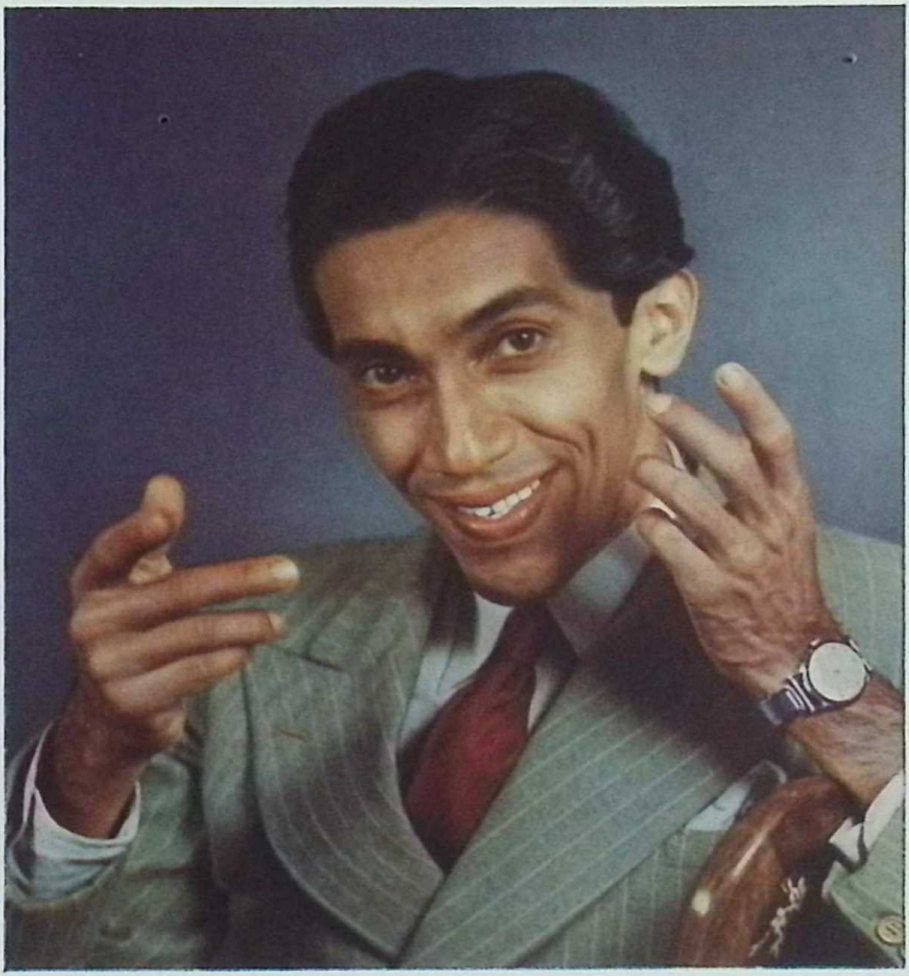
Plate 22

The well-balanced colors in this living room need no comment. (Photo by H. Berger)

An example of how to make a good picture of a landscape. The tree in the foreground gives a picturesque frame for the main subject. The person enlivens the entire scene. (Photo by F. Birzer)

Plate 24

The colors in this memento of a "family occasion" make it a picture of permanent effect. (Photo by H. Berger)

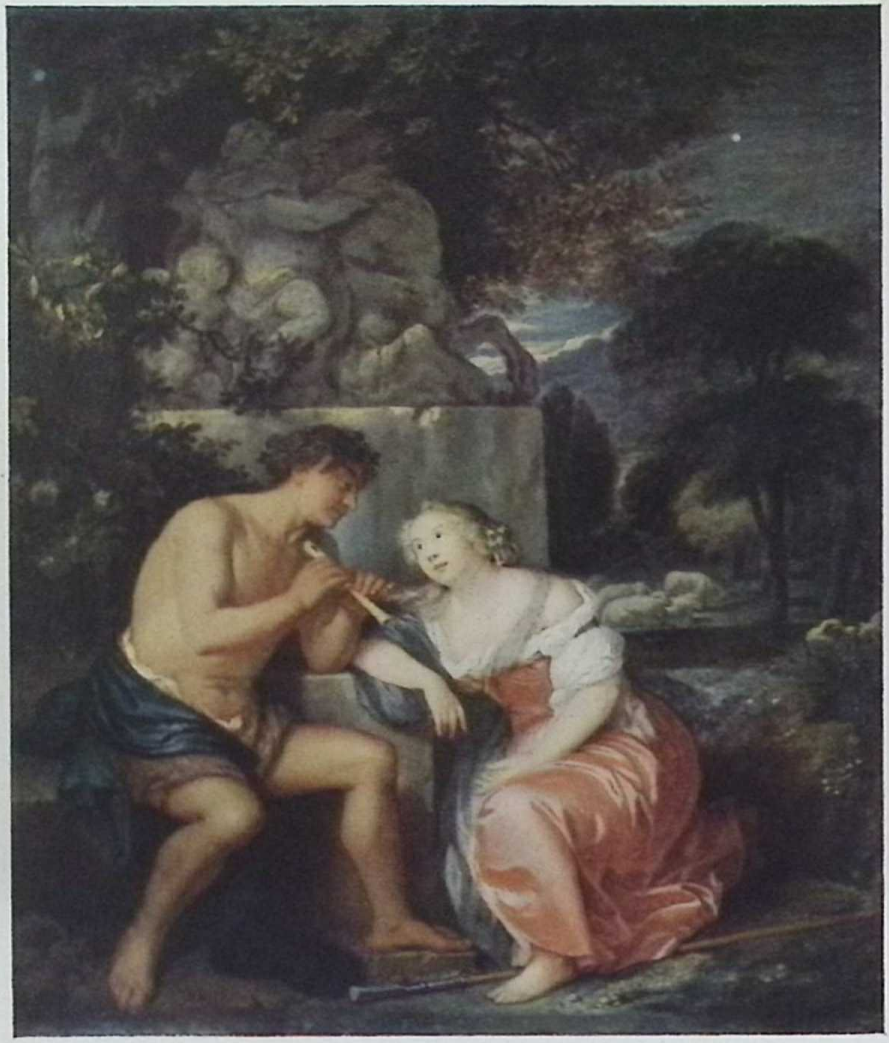


The speed of the Agfacolor-film allows exposures full of expression and motion also in the studio.
(Photo by W. Lange)

Plate 26

This example shows how well the distance and the clouds in a landscape picture are recorded by an Agfacolor exposure without any filter. (Photo by Siv Nebo)

The Agfacolor-film can be used to great advantage not only in the summer, but also in winter time, as can be seen by this picture. (Photo by Siv Nebo)



A reproduction of an old master. Special experience is required to take such pictures as well as absolutely even lighting. (Photo by Prof. W. Hege)

It is thus most essential when arranging the lighting to remember that it should be of such a quality as to avoid the need for retouching of a serious kind.

Make-up

Nor should the model be permitted to use make-up on a scale that would defeat this object, for the use of make-up in such a manner as to hide the natural structure of the skin is unpleasant in the color print. To enhance the natural color of the skin, a quite light foundation is all that is needed, followed by a very sparing use of powder. The lipstick and eyebrow pencil may then be used with discretion. In printing portrait negatives, the first essential is that the flesh tones shall appear natural: if this is done, then it is not essential that the clothes worn by the model may not be perfectly reproduced color for color.

If an irregular or uneven-toned background is used, it is essential that it should be properly in focus, since any lack of sharpness here will have a highly unpleasant effect in the print. In general a neutral background — perhaps silver-grey or brown in hue — is more satisfactory, although there is nothing to prevent a light background from being used, and illuminated with light of any desired color which happens to suit the subject of the exposure. In any case, however, the model should not be placed so close to the background that the shadows he or she throws on the background are visible from the camera lens.

Grey scale

For all exposures where correct color reproduction is important, it is strongly desirable to use a grey scale at the edge of the camera field, from which the exposure given to the print will be determined. If the scale is present, it is very much simpler to choose the most perfect filtering possible for the print, since when the grey scale is correctly printed as grey, all other colors will be most perfectly reproduced in the positive. But it must be remembered that a completely accurate reproduction of colors in a photographic process demands far more care and attention to technicalities than is possible in any commercial color process, so that some compromise between the optimum color reproduction of which the process is theoretically capable and the convenience of a relatively simple practical exposing technique is essential. It thus happens that certain colors or objects will appear in the print in somewhat different hues from those they presented to the eye. In particular, many colors look different in daylight and in half-watt light, so that when exposures are made in half-watt light in the studio, the colors are characteristic of that form of illuminant. If the resulting print is examined later in daylight, it is to be expected that slight differences in color will be detected between the original and the positive.

Exposures with flashs

Exposures with flashbulbs or electronic flash

The use of flash, i. e. flashbulbs or electronic flash is gaining more and more ground in color photography, too. Due attention should be given to the guide number of the individual light sources, this is of particular importance. It is found according to the formula: —

Guide Number = Stop Number × Distance in feet.

For instance, with a guide number of 72, the flash may be used at f/8 at a distance of 9 feet, or at f/5.6 at a distance of 13 feet. The various manufactures state the guide numbers of their respective instruments. The reflector (its shape etc.) may account for differences in the guide numbers of otherwise identical light-sources. Guide numbers computed for the speed of monochrome negative films cannot by applied to the speed of a color film without consideration of the fact that the exposure latiude towards underexposure of monochrome films is noticeably larger than that of color films. Hence, relatively larger guide numbers are given for monochrome films; if they were applied to the speed rating of a color film, excessively thin negatives, which are difficult to print, would be the outcome. Therefore, the following rule-of-thumb should be observed: —

Exposure rules for flashs

In the case of *monochrome films* it is *better* to use one stop larger the guide number (this avoids the need for hard or extra-hard paper during printing).

In the case of *color negative films*, the *next-larger stop number* must be used if the guide number for the speed of the color negative film has been derived from that given for monochrome film.

The guide numbers are particularly small for *Agfacolor Reversal Film compared with* exposures on *Agfacolor Negative Film "T"* at least *the next-larger stop* should be used in order to get correctly exposed tranparencies. Thus, the speed of the Agfacolor Reversal Film is only rated at 5 Weston (10/10° DIN), whereas it is stated to be 16 Weston (15/10° DIN) in daylight. The cause of this at first sight surprising fact is the following: —

With subjects lacking in contrast and receiving flat lighting, reversal films (this applies equally to color and monochrome reversal films) require more light than negative films of comparable speed. It is therefore stated in the directions for the use of Agfacolor Reversal Films that $1^1/_2$ — 2 times the exposure time indicated by the exposure-

meter is required for overcast sky, dull weather, or high mountain photography in snow, i. e., whenever the contrast range is similarly small as with flash subjects receiving frontal illumination. If the flashlight source is arranged strongly to one side of the subject, causing strong contrast, identical guide numbers will indeed apply with Agfacolor Reversal and Negative Film T, as should be expected from the practically identical speed of both films.

If exposures are to be made with electronic flash with fully synchronized cameras the flash should be connected to the X-contact. It is also important that with cameras equipped with focal-plane shutters the exposure time should not be shorter than 1/20—1/30 seconds if electronic flash is employed.

Electronic flash is also very useful to light up heavy shadows of subjects in daylight. Care should however be taken that the light from the flash does not swamp the daylight. Generally, the effect of the flashlight source is controlled by the aperture (guide number!); the chief lightsource of daylight exposures, i. e. the effect of the sunlight on the film regulated by the exposure time.

If Agfacolor lengths of film have been exposed to electronic flash exclusively, the development of Agfacolor Negative Film should be extended by 30—50 %. With normal developing time, electronic flash exposures on color negative film generally turn out too soft. If on a length of film normal and electronic flash subjects are mixed, normal development time (6—7 minutes) should be applied, and the electronic flash negatives printed on Agfacolor Paper Hard.

Photomicrography. *Photo-micrography*

Agfacolor film is particularly suited to the demands of the microscopist, since it reproduces details of structure and form in a more pronounced manner than is possible with monochrome film. No filter should be used during exposure: the type T film is necessary with arc-lamp illumination, and the type K film with incandescent filament lamps. In contradistinction to everyday photography, in which filtering in printing is simplified by having some standard of reference (e. g. human faces, blue sky or green foliage) to work by, the printing filter in photomicrographic work can only be determined by the microscopist himself, so that in this field personal processing and printing is essential.

Photo-copying. *Photo-copying*

There is a very frequent demand to reproduce paintings by means of color-photographic material. Both kinds of Agfacolor Film, Reversal as well as Negative, are suitable for this purpose. However,

the following important points should be observed: — The best reproductions of colors are obtained with exposures in diffused daylight. If this is not available or cannot be used, particular attention should be given to a perfectly even lighting, free from reflections, of the subject (check with luxmeter). Prolonged development (up to 12 minutes) of the negative is an advantage in photocopying on Agfacolor Negative Film. Thus a hard gradation is achieved, corresponding to the use, generally and of more contrasty negative material in black-and-white reproduction work. The study of Part C, Masking is especially recommended where colored reproductions are to be made.

G. Processing Agfacolor materials

There are three essentials which must be observed by all those who wish to process their own Agafcolor exposures and obtain consistent results. These are —

1. Extremely high standards of cleanliness in work,
2. Precise application of the instructions given, and
3. Strict adherence to the times and temperatures prescribed.

It is well known that Agfa materials for monochrome photography have so great exposure and processing latitude that the user may treat them in the light of nature yet still get satisfactory results. Similarly, the provision of many contrast grades of Agfa bromide paper makes it possible to produce a satisfactory print from almost any negative at all. This is not the case in color photography: those who wish to process Agfacolor materials successfully must set their artistic temperament on one side and proceed by the light of science. The well-known statement that "I adjust the developer temperature and time of development by instinct" has no place in color photography, and it must be supplanted by the dark-room clock and the thermometer, coupled with the ideas of cleanliness which we associate with hospital life. There is plenty of room for instinct and the artistic temperament in the Agfacolor process, but they are needed before the exposure is made, and unless they are supplemented by a strict adherence to cleanliness, and to the times and temperatures given in the instructions, they will be wasted. It is, of course, true that a certain amount of latitude — both for exposure and in processing — exists in Agfacolor materials, but these should be used purely as safety factors and not relied on. Thus, Agfacolor Negative film has all the advantages of a negative process, and has quite a considerable exposure latitude — but it only gives its best performance when correctly exposed. The same thing is true of its processing: the times of treatment specified may be slightly varied, with the usual result that longer development will give a denser and more contrasty image, while shorter development produces a thinner and flatter one. But the

Adherence to cleanliness, time and temperature

processing times specified in the instructions are those worked out from long experience by Agfa as giving the optimum density and contrast of negative image, and in conjunction with correct exposure will always produce a satisfactory result.

The same thing is true of Agfacolor Paper, which has some of the exposure and processing latitude associated with the Agfa monochrome printing papers. Yet just because it is not always possible to get a satisfactory print the first time, and because the trial print and final print must be identically processed if they are to correspond with one another, the processing must be uniform and consistent throughout.

In general, therefore, the following instructions must be followed to the letter.

The dark-room

The dark-room

Where it is intended to process Agfacolor material frequently, it is very desirable to have a special dark-room in which it is worked, and which is not used for ordinary monochrome photograpy. Some of the solutions used in the ordinary photographic process have fatal results if they come into contact with Agfacolor materials, and the use of a separate dark-room for the two processes avoids all accidents from this source.

Dark-room illumination

Dark-room illumination

Agfacolor film is preferably developed in total darkness, for no safelight is "safe" for it if allowed to act for more than a very limited time. If it is essential that some light is present, however, the dark green No. 170 Agfa safelight filter must be used, in conjunction with a 15-watt lamp, and the lamp must not be closer to the working plane than 75 cm (30 inches). Once the eye is accustomed to this admittedly dim light, it will be found that the clock, the tanks, and the other accessories such as film clips can be readily seen and manipulated. Since it is often unpleasant when coming out of the dark-room to accustom the eyes to the brilliant daylight, and then to have to accomodate them once more for the safelight, it is useful to wear the "adaptation glasses" used by some radiographers or else to put on dark sun-glasses with side shades when leaving the dark-room. If this is done, then the re-adaptation to the safelight of the dark-room will be quite rapid.

Development

Development

After exposure, Agfacolor Negative films are developed in a special color developer to complementary colors. The Agfacolor

chemicals must be used for this purpose, and the solutions made up as directed on the package, using *clean* vessels of glass, earthenware, stainless steel, plastic or *unchipped* enamelled steel. The powdered chemicals must not be permitted to blow about as dust while making up the baths, and vessels of materials other than the above are fundamentally unsuitable. It is preferable to keep one vessel to make up each individual solution, and to reserve it exclusively for that purpose, but where this is impossible a vessel used for more than one kind of solution must be thoroughly chemically cleaned each time it is used. The baths used successively in Agfacolor processing work perfectly in their correct order, but are fatal to the image when applied mixed with one another.

The general operations of negative development and of reversal development are very different, strict adherence to the following instructions is therefore recommended (cf. fig. 51 and 52).

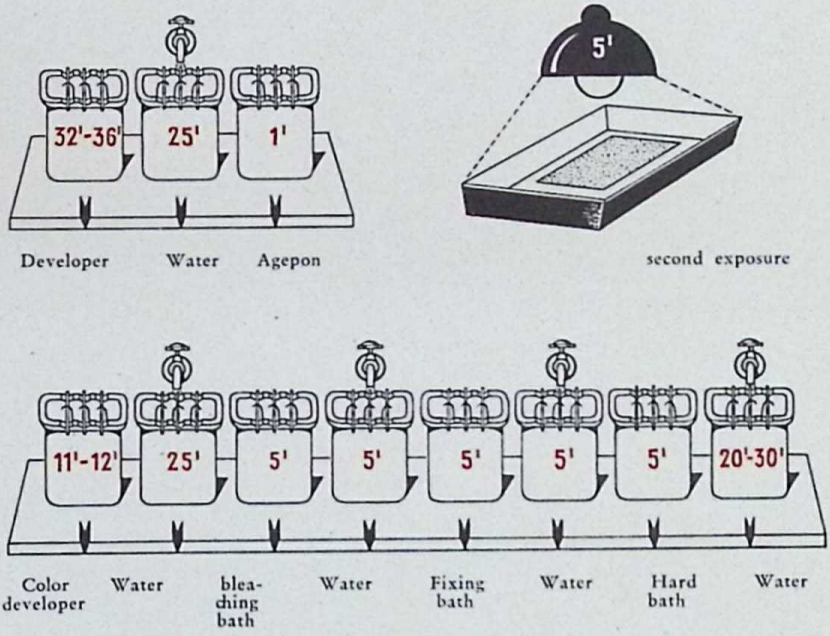


Fig. 51

The operations in processing Agfacolor reversal film.

		Time (Mins.)	Temperature (°F.)	Yield per 1 (35 fl. oz.)	Keeping Qualities in well-closed tank (floating lid)
In Darkroom (Agfa Filter 170)	1.) First Developer (I) for Agfacolor Reversal Film				
	Tank	32—36	65	3—4 Agfacolor Reversal Cut films 7¼×9¾" or rollfilms or 35 mm films (36 exposures)	1 week
	Dish	28—36	65	as above	discard after the end of each working day
	2.) Thorough intermediate wash	25	57—68	—	—
In Daylight	3.) Wetting Solution (Agepon 1:200)	1	57—68	10—12 as above	2 weeks
	4.) Second exposure 500 W lamp, 40" distance	5	—	—	—
	5.) Color developer for Agfacolor Reversal Film (II)	11—12	65	6—7 as above	2 weeks
	6.) Thorough intermediate wash	25	57—68	—	—
	7.) Bleaching Bath (III) for Agfacolor Reversal Film	5	65	6—7 as above	2 weeks
	8.) Intermediate wash	5	57—68	—	—
	9.) Fixing Bath (IV)	5	65	6—7 as above	2 weeks
	10.) Intermediate wash	5	57—68	—	—
	11.) Hardening Bath (V) for Agfacolor Reversal Film	5	65	10 as above	2 weeks
	12.) Final wash	20—30	57—68	—	—

a) *Development of Agfacolor Reversal Cut Film*

Agfacolor Reversal Cut Film

Processing of Agfacolor Reversal Cut Film is carried out in the solutions spacially prepared for it according to the following directions. The table also contains details of the yield and keeping qualities of these solutions.

The utmost cleanliness should be observed during the processing of Agfacolor Reversal Film. Dishes, tanks, tongs and clips should be made of chemically inert material, preferably glass or plastics for tanks and dishes, V A for clips and tongs.

All processing solutions should be protected against mutual contamination by keeping a sufficiently large distance between them. Especially the first and colour developers should be kept free from fixing and bleaching solutions, which may be carried over by hand, on frames, clips, etc. The solutions should be made up in a separate room to avoid contamination of work-bench and baths with hypo-dust.

Agfacolor Reversal Films should not be touched by hand needlessly, as this may lead to mechanical damage and colour stains. Developer temperature should be watched closely (65°F., tested thermometers). Temperatures of the remainder of the processing baths may vary between 61 and 68°F. Working temperaturs exceeding 68°F. may result in stripping the emulsion from its base due to excessive swelling of the gelatine. Procesisng times given for bleaching, fixing and hardening may be exceeded.

First development

First Development: — Agfacolor Reversal Film must be handled in complete darkness or at a great distance from the darkroom lamp, up to its immersion in the first developer. After 5 minutes' development the darkroom lamp with Screen 170 may be switched on. A 15W lamp should be used in it, and its distance from dish or tank should be at least 30".

Developing time for tank processing should be 32 minutes, and for dish processing 28 minutes (moderate, constant agitation should be maintained to ensure even development) for the correctly exposed first film. This time should be gradually extended for each subsequent area of $7^1/_4 \times 9^3/_4$" cut film sheet until 36 minutes are reached. Tank development is recommended as by far the safest method for Agfacolor Reversal Film, as in this case the keeping qualities of the developer solution are improved owing to reduced danger of oxidation.

In all processing baths, moderate agitation of the films should be maintained at all times. During tank development Agfacolor Films should be slightly moved in the tank vertically and sideways for the

Agfacolor Reversal Film

first 1 — 2 minutes, and then for appr. 10 seconds every 2 — 3 minutes to avoid the danger of streaky, thin development. Too old, exhausted, or too cold first developer gives pictures of excessive density with blocked highlights and a yellowish-brown cast. If the solution is too fresh or too warm, or if the development time is exceeded, the result will be increased first development fog, hence reduced shadow density together with burnt-out highlights.

First development is followed by a thorough *intermediate wash* of at least 25 minutes' duration, in running water. After this intermediate wash, Agfacolor Reversal Film processing may be continued in white light. The following treatment in a *wetting agent bath* (Agfa Agepon diluted 1 : 200) is designed to prevent the formation of water droplets on the film; they may act as lenses collecting the light during the second exposure, causing circular spots.

Seond exposure

Second exposure: — For the second exposure, a 500W lamp is used at a distance of 40" from the film, turning the cut film slowly and continuously for 5 minutes, evenly exposing its emulsion side and back.

The second exposure is necessary in order to affect the remainder of the silver bromide, which is subsequently developed to a color positive in the color-coupling developer. Miniature and rollfilms, held in frames, should be turned in their frames after 2½ minutes' exposure and given the same time of exposure again to enable the back of those portions of the film which were covered by the cross-bars of the frame also to be affected. If this precaution is not taken, brownish-red discolorations will be seen where the film had touched the cross-bars of the frame. Therefore, frames with cross-bars made of glass-clear Plexiglas are especially recommended to avoid frame markings. The film should not be brought closer to the 500W lamp than 32", ohterwise the top layer of the emulsion might melt. The second exposure can also be applied by keeping the films in a dish under water. Lighting the films from both sides then is also essential.

Color Developer

Color Developer: — After the second exposure the film is processed in the color developer for Agfacolor Reversal Film for 11—12 minutes at 65° F. The residual silver bromide is reduced to metallic silver, and at the same time the positive color image (yellow in the top, magenta in the middle, and cyan in the bottom layer of the emulsion) is produced. Insufficient color development (developer too old or too cold or time of application too short) gives deficient shadow density and too thin colors.

The developing agent used in Agfacolor Developer is no more toxic than metol, etc., generally used in photography, and is harmless

Agfacolor Reversal Film

in all normal cases. However, it is a well-known fact that some individuals are allergic to developing agents; they should therefore avoid contact with color developer.

Magnesium sulphate Bath

Magnesium sulphate Bath: — In districts with a very soft water supply formation of bubbles or reticulation might occur during the intermediate rinse. This fault is prevented by the application of a 2 — 3 % magnesium sulphate bath (20 — 30 g magnesium sulphate dissolved in 35 fl. oz. of water) between color development and the following thorough wash (immersion time appr. 3 minutes).

Intermediate wash

The following 25 minutes' thorough intermediate wash is very important, since color developer is retained by the emulsion if insufficiently washed, and combines with the following bleach bath to produce a yellow-to-brownish color veil which it is impossible to remove.

Bleaching Bath

Bleaching Bath: — Treatment in the bleaching solution lasts 5 minutes at 65°F. The fresh solution is yellowish, and appears green after use. The yellow fog caused by bleaching solution which is too old can be removed by a second bleaching and fixing treatment. In the bleaching Solution for Agfacolor Reversal Film the entire silver is converted into soluble silver salts. After immersion for 2 — 2½ minutes a yellow-brown image becomes visible on the emulsion side, while the back shows a uniform blue-green color. Treatment of the film in the bleaching bath is extended to 5 minutes to ensure complete conversion of the silver.

Fixing Bath

Fixing Bath: — After *5 minutes' intermediate wash* the soluble silver salts are dissolved in the subsequent fixing solution for Agfacolor Reversal Film (5 minutes at 65° F.); the pure dye-image appears after 2 — 2½ minutes, but fixing of the film must be continued to a total of 5 minutes to ensure complete solution of the silver salts.

Hardening Solution

Hardening Solution: — The Hardening Bath for Agfacolor Reversal Film follows after a further *5 minutes' intermediate wash* (immersion time 5 minutes at 65° F.); its purpose is to harden the color film and to stabilize its dyes. The Agfacolor Reversal Film is now less liable to damage than before the hardening process and, after a final rinse of 20 — 30 minutes, it may be dried in a drying cabinet at temperatures as high as 100° F.

Agepon Bath

To ensure quicker drying and to prevent the formation of drying marks Agfacolor Reversal Film should either be wiped gently with a piece of soft leather, or, preferably, be treated in an Agfa Agepon Bath (dilution in water 1 : 200) for ½ — 1 minute.

Controll of all solutions

The following step is recommended for the control of all processing solutions, especially the first developer: — An Agfacolor

Reversal Film is given normal exposure throughout. Two exposures of this film receive standard development. They will serve as control for the test development carried out on each subsequent day with other pieces of the exposed film prior to the commencement of normal development. If these test developments turn out to be standard, it can be assumed that any faulty results obtained are due to incorrect exposure.

Agfacolor Negative Film

b) *Development of Agfacolor Negative Film*

The following working sequence is recommended in processing Agfacolor Negative Film:

Developer for Agfacolor negative and positive film
Agfacolor Negative Bleaching Bath
Agfacolor Negative Fixing Bath.

The individual processing steps are largely similar to those applied to monochrome negatives, i. e. they do not on the whole require highly specialized training of the user.

Processing Sequence Baths	Time (mins.)	Temperature (° F.)
Developer for Agfacolor negative and positive film	6—7	65
1st wash (thorough)	15	—
Agfacolor Negative Bleaching Bath	5	62—68
2nd wash	5	—
Agfacolor Negative Fixing Bath	5	62—68
Final wash (thorough)	20	—

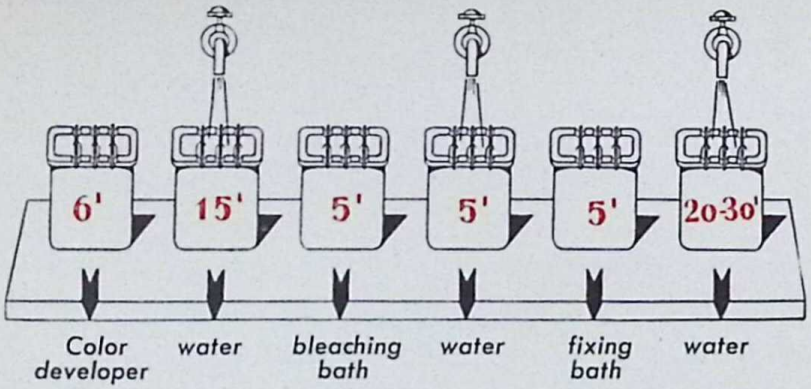


Fig. 52
The operations in processing Agfacolor Negative Film

The Agfacolor Negative Developer should be allowed to mature for twelve hours after making up before it is used: this will ensure even results in use. Apart from the time of development above, which *must be rigidly kept at 6—7 minutes,* the times of treatment indicated are the minimum permissible: in operations other than development, therefore, the films may be left for rather longer in the bath or the washing water without any risk of them being affected by the fact.

Agfacolor Negative Film

Tanks should be of glazed earthenware, plastic or stainless steel: enamelled steel can only be permitted when the vitreous enamel is unchipped and perfect in surface. Circulation of the developer by pump is strongly recommended for large firms using tanks of considerable volume in order to ensure that the solution is of uniform character throughout the tank, but the circulation must be so arranged that currents of developer past the negatives in the tank do not occur. Small spiral developing tanks may also be used provided that the films are loaded into them carefully and the washing between the succesive baths is particularly thorough, but it is desirable here to have a different outer container for each particular bath used, as well as for the washing operations. When using either deep tanks and small daylight tanks, ist is essential to provide sufficient agitation during processing, so that where processing is continuous it is desirable to use separate tanks for the three washing operations.

Only plastic or stainless steel clips should be used with Agfacolor films. If the clips show any sign of being attacked by the baths, or become badly stained they should not be used again.

Agfacolor Negative films do not have hardened emulsion layers, and in the wet state are exceedingly tender and sensitive to mechanical abrasion. Throughout the operations of processing, therefore, the surface of the film should not be touched except by the solutions and washing water.

During the various operations, the following points must be observed:

Color Developer

Color Developer

The function of this bath is to develop the silver images in the three exposed emulsions of the film, and simultaneously to produce dye-images at the same points as the silver by the reaction between developer oxidation products and color formers. Simultaneously, the color is bleached out of the anti-halation layer on the back of the film.

Agfacolor Negative Film

The color developer is very sensitive to oxidation, and should be stirred gently in order to avoid producing air-bubbles which would dissolve in it. The tanks or other vessels in which the developer is kept should be closed with well-fitting lids when the solution is not actually in use, and when storing it in bottles, these should be filled up to the brim and well stoppered. The bottles themselves should preferably be of brown glass.

Regeneration of the Color Developer

Regeneration of the Color Developer.

The color developer only contains sufficient chemicals to develop a definite area of Agfacolor Negative film, so that the following remarks regarding control of the solution must be carefully followed. But if the Agfacolor Regenerator solution is regularly added to the tank, the action of the solution will remain constant over the whole useful life of the developer. Regeneration is carried out by adding regenerator solution at regular intervals to make up for the developer taken out of the tank with the developed films preferably after each batch of negatives has been developed, and it is convenient to mark the tank inside with the original height of the developer and then add regenerator solution to this level.

On the average 15 to 18 ml. (3,9—4,7 fl. drachm.) of Agfacolor regenerator solution should be added to the tank for each 36-exposure miniature film or B 2-8 film, or for each four quarter-plate flat films.

It is naturally important here that the tanks should be fluid-tight, since otherwise the effects of leakage will upset the regeneration process. For similar reasons, it is undesirable that dust or dirt in the air should fall into the tank, so that all tanks must be kept covered whenever possible.

With suitable regeneration, each litre of solution (35 fl. oz.) in the tank should prove capable of developing 40 to 50 B 2-8 (120) roll-films, or 40 miniature films, or 150—200 quarter-plate flat films. The developed images will remain constant in quality with regeneration, so long as the time and temperature of development remain unchanged.

After three months, the contents of the tank must be discarded (even if they have not developed this quantity of material) and replaced with fresh developer, for the above economical use of the developer is only attained when the tank is in constant and daily use. If it should be found, moreover, that even under correct regeneration the negatives tend to be flat in contrast or show an unexpectedly high fog level, it is essential to discard at once the tank of solution and make up fresh developer.

Agfacolor Negative Film

It is very convenient to arrange that regenerator is added to the tank as soon as the level falls from the original height on the tank wall. A simple method of doing this automatically is to take a bottle of a suitable size, and fit it with a rubber bung bored centrally to take a glass tube. A rubber tube with a pinch-cock is pushed on to the glass tube, and the bottle then filled with regenerator solution. When the whole contrivance is inverted, the regenerator runs down the glass and rubber tubes but does not come out because of the pinch-cock, and the end of the rubber tube may be fastened to the inner side of the tank so that its end lies just on the mark indicating the level of the developer when freshly made up. The pinch-cock is now removed, and as soon as the tank level falls, regenerator will fall from the stock bottle until the solution again rises to the original mark, when the flow from the bottle will stop again.

Controlling the Developer Action

Controlling the developer Action

Where Agfacolor Negatives are developed on a large scale, it is best to control the action of the developer by putting through it at regular intervals — preferably before starting work — a test strip of film with known exposure. Such a test strip is readily produced by exposing the 36 pictures of a miniature Agfacolor negative film on one subject, so that each picture is identical to all the others. To test the developer, a picture or two is cut from the test film, and developed: by comparison with the image given in a perfectly fresh developer the qualities of the solution can be determined. This form of test is valuable in that it will not infrequently save valuable and irreplaceable negative material from being put through a solution that is already worn out. The condition of the other processing baths is also indicated in a similar way by the test strip.

Development in small tanks

Development in small tanks

Where only small numbers of Agfacolor Negative films are processed, it is more satisfactory to use a small closed tank of the "amateur daylight" type. This has the advantage that only a small volume of developer is used, and the solution may either be discarded after using once or else used to develop the appropriate maximum number of films consecutively before it is poured away. It is, however, very unsatisfactory to pour back the used developer into the stock developer bottle and mix it up with the rest of the unused developer there.

When using these small tanks, it is particularly important that the washing processes are thoroughly carried out, and that the baths

Agfacolor Negative Film

are poured in and out of the tank as rapidly as is possible. Where moderate numbers of films are processed, it is often convenient to use the film-carrying portion of these small tanks only, and to have larger vessels in which the processing solutions are kept. In this way, only the drum, or spiral spool, holding the film moves from one solution to another; the process of washing, and changing from one bath to the next is very much simplified.

Keeping power of Developer

Keeping power of developer

The keeping qualities of Agfacolor negative and positive film developer, when kept carefully and regenerated according to the instructions above, are approximately three months. (See page 110.)

Development Latitude

Development Latitude

A certain amount of development latitude exists in Agfacolor Negative film, so that under-exposure to some extent can be corrected by increasing the development time. This correction should, however, only be applied in exceptional cases, for it is only by adhering to standard times and temperatures of development that any consistency in results can be achieved.

Where exposures or works of art or of advertising subjects (e. g. film advertising) are involved, it is also frequently useful to have a rather harder contrast than usual in the negative. In such exceptional cases as these, negative development may be increased to twelwe minutes, but such treatment as this must never be given to normal kinds of exposures, for the resulting image would be far too hard in quality for satisfactory results.

Development of electronic flash exposures

Development of electronic flash exposures

Agfacolor Negative Films containing exposures with electronic flash exclusively should always be given a development of 8 — 9 minutes. If the film includes exposures taken under varied lighting conditions, the normal 6 minutes' development and printing of the electronic flash negatives on Agfacolor Paper Hard is recommended. This precaution is explained by the fact that the extremely short exposure times encountered with electronic flash cause a considerable flattening of the negative film gradation due to the so-called Reciprocity Law Failure. Compensation is therefore obtained either by the above-mentioned extended development of the negative, or its printing on Agfacolor Paper Hard.

Magnesium sulphate bath

Magnesium sulphate bath

In districts where the water is very soft, small bubbles may appear in the negative emulsion, or some of the gelatine may dissolve

away completely. This is due to the change from developing solution to the plain water of the first wash, or to temperature differences between the developer and the washing water. All such temperature differences should be avoided, and the negative placed, after development and before washing, in a bath of 2 % magnesium sulphate in water. After two or three minutes the negative may be transferred to the washing water and processing continued. The magnesium sulphate bath will treat the same number of negatives as the unregenerated developer: 6 B 2-8 (120) roll-films per litre. The chlorine content of many water supplies is high at present, but this does not affect Agfacolor materials.

Formalin Bath: *Formalin Bath*

If in particularly unfavourable processing conditions the magnesium sulphate bath is still not effective enough, stripping of the emulsion is avoided with certainty by applying an additional formalin bath following the magnesium sulphate bath:

2—3	minutes	2—3 % magnesium sulphate bath
2	„	rinse (not exceeding this time)
5	„	5% formalin bath (125 ml. formaldehyde in 1000 of water)
15	„	wash (thorough)
5	„	bleaching bath etc. as with normal processing

If the 15 minutes' time wash was not sufficient enough a green fog may occur.

First wash *First wash*

The process of development does not end when the film is removed from the color developer: it continues in the emulsion layers until the last trace of developing agent has been removed from the layers by the washing water and the process of diffusion. It is thus important to continue the first wash for at least the time specified, for otherwise the development process may be curtailed and the image suffer accordingly.

Bleaching bath *Bleaching bath*

In this bath, the yellow filter layer below the top (blue-sensitive) emulsion of the film is bleached, and all the metallic silver images reconverted into a soluble silver salt. As soon as the film has been immersed in the bleaching bath for one minute, the white light may be turned on and used during the rest of the processing. The image developed in the film cannot be seen in the dim light of the safelight used during negative development, but in the bleaching bath

Agfacolor Negative Film

it will appear in two colors. The front will show the yellow dye-image produced in the top layer, while the back will show the blue-green image of the bottom layer: the central magenta image remains invisible because it is hidden by unexposed silver bromide and by the soluble silver salt produced in the bleaching bath by reaction with the metallic silver images.

The Agfacolor Negative Bleaching bath is somewhat sensitive to light, and should be stored in bottles of brown glass. In its fresh state the bath is a full yellow color: during use it will eventually turn greenish, and at this point is must be thrown away and replaced by a fresh solution.

Second wash

Second wash

The function of the second wash is to remove the bleaching bath remaining in the emulsion layers of the film. At least five minutes must be allowed, for it is important to transfer as little of the bleaching bath as possible into fixing solution.

Fixing bath

In this bath, both the residual unexposed silver bromide and the soluble silver salt into which the bleaching bath has changed the silver images is removed, thus leaving plain gelatine layers with the dye-images of a complementary-colored negative in them. Since all the silver of the orginal emulsion layers is dissolved in the fixing bath, the solution has a higher silver content than that of the monochrome photographic process. It is therefore very desirable to recover the used silver by the Agfa Reargan process.

Agfa Reargan

The composition of the Agfacolor Negative Fixing bath differs considerably from the fixing baths of ordinary monochrome photography. On no account, therefore, should fixing baths of ordinary formulae be used for Agfacolor material. Just as in monochrome photography, the least trace of fixing bath in the developer or in the first washing water is fatal to the proper working of the color developer solution.

Final (third) wash

Final (third) wash

This operation serves the purpose of removing all the processing chemicals which still remain in the lagers of the film, and it is important that it is thoroughly carried out, for traces of chemicals remaining in the film will impair its keeping qualities.

Wetting agent

Agfacolor Negative Film

Wetting agent

After the final wash, the films should be rinsed briefly (10 to 20 seconds is enough) in an aqueous solution of wetting agent. This will prevent water-drops forming on the film, so that it will not be necessary to wipe over its surface with a leather before drying. The wetting agent recommended for this purpose is that supplied by Agfa Leverkusen under the name of "Agepon". After this rinse, the films should be dried at once.

Limits of use of the processing baths

Limits of use of the processing baths

Each litre (35 fl. oz.) of the processing baths is capable of treating the following quantities of film material:

	Miniature film cartridges (36 exposures)	Karat cartridges	Rollfilm B/2-8 (120)	Flat film 9×12 cm (1/4 plate)
Agfacolor Negative Developer	6	18	6	24
Agfacolor Negative Bleaching Bath	10	25	10	40
Agfacolor Negative Fixing Bath	6	18	6	24
Magnesium Sulphate Bath	6	18	6	24

Drying

Drying

The drying of processed and thoroughly washed Agfacolor films is identical to that of ordinary monochrome films. Although the Agepon wetting agent is preferably used (see above) to dispose of water-drops, the films may be wiped down cautiously with clean chamois leather or an Agfa viscose sponge, and then hung up in a dust-free place or a drying cupboard. Direct sunlight, or too high a drying temperature must not be allowed to reach the films, and where a heated drying cupboard is used the temperature should on no account be higher than 30° C. (87° F.)

Agfa Film Lacquer

Agfa Film Lacquer

The preservation of the unhardened emulsion from abrasions and scratches is important, so that the use of a lacquer is strongly recommended. The Agfa Film Lacquer should be used immediately the films have been dried, and not only prevents scratching but also removes to a large extent the effect of any existing abrasions. The dried film is merely immersed briefly in the lacquer and then allowed to dry naturally. Should serious abrasions occur later on, the film may be re-lacquered in the same manner. Should prior removal of

Agfacolor Negative Film

the varnish-layer present be found necessary, the film should be brought into a 1 % ammonia solution (4 cc conc. commercial ammonia in 1 L (35 fl. oz.) of water) for 2—3 minutes, followed by drying without further rinse.

The above sequence of processing operations results in a negative image in complementary colors, from which may be printed positives in natural colors either on Agfacolor Positive film or on Agfacolor Paper, in any desired number.

It may be noted that since the finished Agfacolor negatives do not have any silver image, it is not always easy to distinguish the emulsion side from the free base. The simplest way of determining the emulsion side is to look for the emulsion number which is embossed on the leader strip: when this number can be read correctly, the emulsion side faces the observer. Since roll-films are often cut up into single pictures, it is desirable to write the emulsion number on the emulsion side at the clear edge. This will simplify the determination of the printing filter later on very considerably. Flat films are notched by the usual code, so that their emulsion side is readily distinguished. Type T-film has one notch, type K-film two notches.

Agfacolor negatives are particularly suitable for making enlargements on Agfacolor paper. In general, in fact, it may be taken for granted that the really best result from any Agfacolor exposure is an enlargement: contact prints do not show the full quality and pictorial effect of the Agfacolor process.

To avoid disappointments, and to save both time and money, it is essential to use genuine Agfacolor chemicals when processing Agfacolor Negative films. Unless Agfa products are used, there is no guarantee of consistent results.

Prints and enlargements

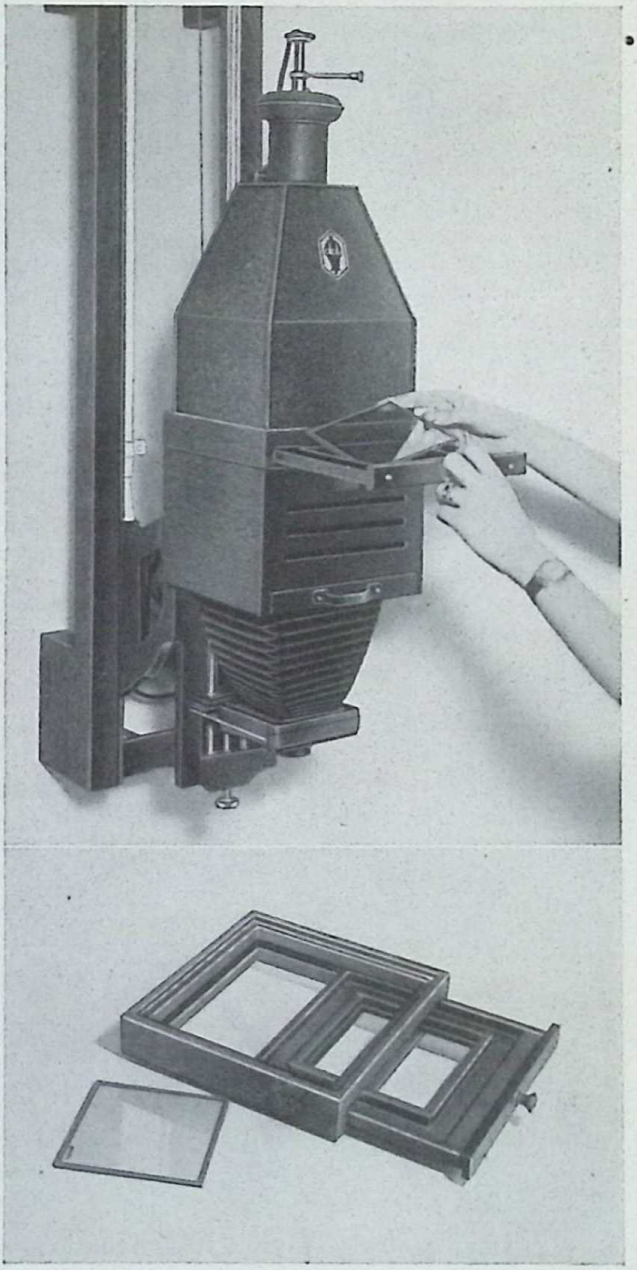
Making prints and enlargements on Agfacolor Paper or on Agfacolor Positive film

Where printing or enlarging on Agfacolor positive material is carried out to any serious extent, it is just as desirable to set aside separate work-rooms for the process as in the case of negative material. This is due not only to the fact that the solutions must not be confused or contaminated by those used in monochrome photography, but also because of the essentially different illumination needed in the two processes.

Dark-room illumination

Dark-room illumination

Agfacolor positive material, whether paper or film, must be panchromatically sensitised in order to record the three subtractive



a

b

Fig. 53
Enlarger with filter drawer for printing filters:

(a) enlarger

b) filter drawer unit

Agfacolor Positive Film and Paper

primary colors of the negative. A high level of dark-room illumination, such as that given by the No. 112 or 113 Agfa safelight, which is usual with monochrome printing and enlarging, is thus out of the question. Because of the low general sensitivity of positive materials, however, it is feasible to use a considerably higher level of illumination than that needed for monochrome panchromatic materials. By using the No. 166 Agfa safelight filter with a 15-watt lamp, and at a distance from the working plane of not less than 75 cm (30 inches), the materials can be handled in a relatively bright olive-green illumination which will be found very pleasant after a little experience, and this simplifies the printing and processing of Agfacolor positive materials considerably.

Printers and enlargers

Printers and enlargers

In principle, any device used in monochrome photography from a printing frame upwards may be used to print Agfacolor positives. The enlargers used should, however have lenses well corrected for color, and since any scattered light is bound to reduce the color brilliance of the pictures, bloomed lenses with low scatter factors are preferable. If the highest color quality is desired, it is wise to stop down the enlarger lens to f/8, since at this aperture the effect of residual uncorrected aberrations is not important.

Whatever type of equipment is used, however, it is essential that it shall be capable of accomodating the Agfacolor printing filters, since without these there is no possibility of correcting color-cast and similar color distortion. The arrangement for introducing printing filters may range from the very simple, but not very convenient, to the complicated devices which use what one may term "push-button" methods.

Filter drawer

A simple and quite convenient method which has proved to be very satisfactory in practice is the filter drawer illustrated in fig. 53. The enlarger is merely fitted with a distance box between lamp and condenser, into which slips a rectangular drawer to support the printing filters. The drawer should be placed as close to the condenser a possible, and should be so arranged that light cannot reach the latter except through the filter itself. This is necessary to ensure that only filtered light reaches the negative and the print.

A number of firms manufacture enlargers working on this principle, and in case of difficulty the address of one or other of them can be obtained from any of the Agfa agencies or from the Agfa factories. Where an enlarger is already available, a reasonably clever mechanic can quite readily alter it by introducing a filter drawer in order to make it suitable for Agfacolor enlarging. This

arrangement can also be used conveniently to supply filtered light when contact prints are made: the enlarger and filter drawer are used purely as a light source, and ordinary printing frames are placed on the easel. A similar printing filter drawer can often be fitted, too, to the printing boxes used for monochrome roll-film prints: in this case the filter should be as close to the diffusing screen as possible, and should be fitted to exclude all light not passing through the filter itself. The manufacturers mentioned above also provide more complex instruments which allow quicker and simpler changing of the filter.

Agfacolor Positive Film and Paper

Seriograph II

Seriograph II

A special contact printer using devices of the last type for Agfacolor printing is the Seriograph II, made by the Agfa Camera Factory in München. This is shown in fig. 54, and disposes of all necessity for taking filters in and out of the light-path by using filters with a density of 99 (100) units only. The filters here are designed to move continuously in and out of the light-beam, so that when half the beam is covered by the 99-unit filter, the effect is that of a 50-unit-filter. The movement of the filters is controlled by three rotating knobs, so that each filter color is continuously variable between nil and 99 color units.

Varioskop F

Varioskop F

An identical method for filter contral is also used in the Varioskop F, which is an enlarger made for Agfacolor by the Agfa Camera Factory in München. This is shown in fig. 55.

In the course of time, it is certain that other semi-automatic devices will appear on the market for the control of printing filters, as the use and range of the Agfacolor process widens.

Apart from the need for some means of using printing filters during the exposure of Agfacolor prints, the following point must be considered. It is well known that the mains voltage, which is applied to the enlarging or printing lamp, may from time to time vary considerably in value. This means that the lamp gives out more or less than its usual light output, and also that its color temperature changes. In monochrome photography this merely affects the exposures one must give to the printing paper: in the Agfacolor process it affects the color reproduction as well. It is thus essential to include either a voltmeter or an ammeter in the lamp circuit, and regulate the volts across it or the current through it so that the lamp burns at a constant level. This regulation must be continued actually while the prints are being exposed, and it is therefore simpler in the end to instal an automatic voltage regulator which gives the same

Agfacolor Positive Film and Paper

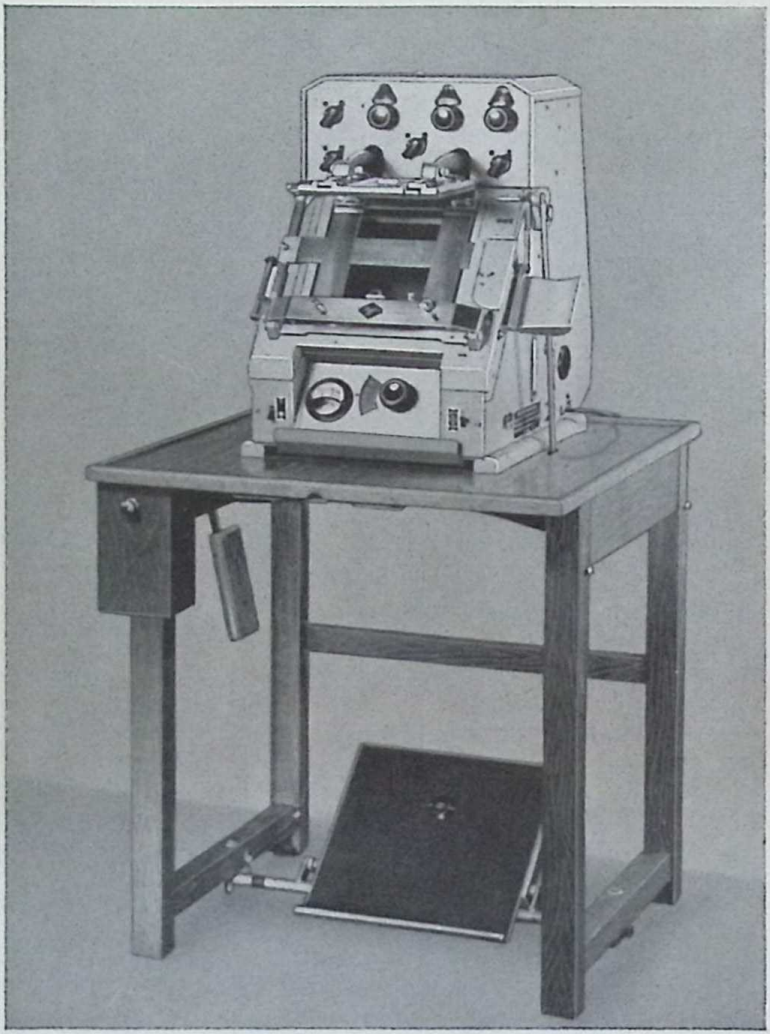


Fig. 54
Seriograph II, made by the Agfa Camera Factory, with filter device for Agfacolor printing

output even if the input from the mains varies widely. Such devices allow the whole attention to be given to the actual work of printing or enlarging, and these automatic regulators may be obtained from the electrical industry without difficulty. (Agfa Agencies or the Agfa Factories will suggest suppliers to those requiring regulators.)

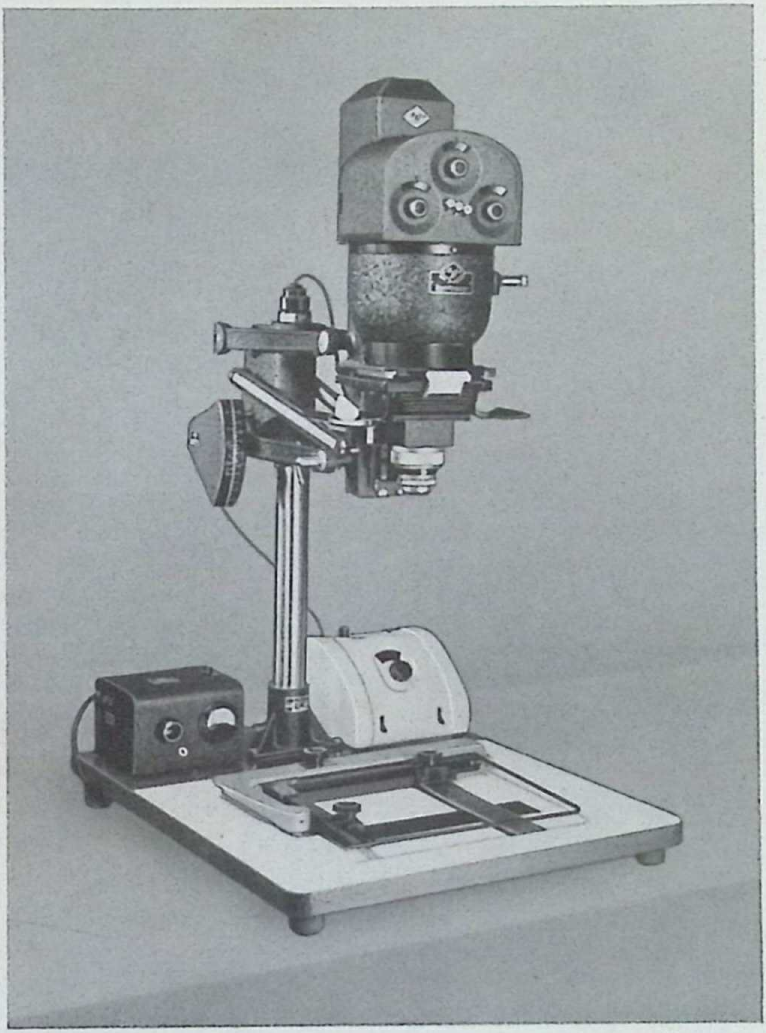


Fig. 55
Color enlarger (Varioskop F) made by the Agfa Camera Factory in München

The final point of importance is to make sure that no stray light escapes from the enlarger or printer which might strike Agfacolor Paper and fog it. The Agfacolor positive materials are very much more sensitive to this form of stray light than is, for instance, Agfa Brovira paper.

Agfacolor Positive Film and Paper

In general the technique of printing Agfacolor Paper or Positive Film does not differ materially from that needed for monochrome papers and films. The negative is placed in the printer or enlarger in the normal manner, and exposed on Agfacolor Paper just as if monochrome paper was being used. The Agfacolor Paper has a sensitivity similar to that of Agfa Brovira, so that it is possible to make a test exposure on Brovira in the first place to determine the exposure required for Agfacolor Paper. If the Brovira print is developed for exactly 90 seconds at 18° C. (64° F.) in Agfa Neutol or Agfa No. 100 formula, and then examined, the same exposure required for it can be used for the Agfacolor print. The speed of the Agfacolor Positive Film is approximately twice as high as that of Agfacolor Paper, hence also that of Agfa Brovira Paper. It equals that of the well-known Agfa Cine-Positive Film (Monochrome). These details should serve as reliable guidance in the production of prints or enlargements on Agfacolor Paper or — Positive Film.

"Majosix"

In place of a trial exposure on Agfa Brovira Paper the exposure-meter "Majosix" produced by Messrs. Gossen, Erlangen is most successfully used for enlargements or prints. This exposure meter consits of a photo-cell and a measuring instrument which gives a direct reading of the exposure-times required for Agfacolor enlargements or prints. (cf. fig. 56.) The photocell is placed on the enlarging or printing surface, in the densest picture area of which detail is still required in the positive. The reading is taken through the filters inserted in the enlager; this obviates conversion of the exposure-times with the aid of filter factors."

The beginner in Agfacolor is strongly recommended to adopt, at first, the following modus operandi, which he will find can later — when he has gained some experience — be simplified considerably.

"Zero-print"

1. Exposing a trial strip to determine exposure-time and color-cast of an unfiltered so-called "Zero-print", and the color-cast of a zero-print whose exposure-time has already been found with the aid of the "Majosix". (See fig. 27a, Plate VI; fig. 29a, Plate X; and fig. 30a, Plate XIV.) This operation can be omitted when experience has been gained, for it will prove possible to assess both the density of the color negative and also the type of color-cast it may contain by comparing with other negatives already printed. The filter required for printing will have the same color as the cast present in the test strip, and it would be quite feasible to make further test strips with increasing densities of the appropriate filter. This takes too much time and uses too much raw material to be practicable.

Therefore, either a mosaic print or a trial print by means of the printing aids described on p. 48 (Colorax, Colormeister, E. K. Strip Printer, Hexagonal Mosaic Filter, Agfacolor Comparator) should be made as a second step.

2a. Producing a Mosaic-print

To produce a mosaic print in order to find the required printing filter 31 densities, the following procedure should be adopted: — (Fig. 29b, Plate VI, Fig. 31b, Plate X, Fig. 32b, Plate XIV). The color of the mosaic filter is given by the color-cast in the test strip: thus the yellow/magenta filter is needed for a red cast, the magenta blue-green filter for a blue cast, and so on. The mosaic filter is placed between negative and paper in contact printing, or over the Agfacolor Paper on the enlarger easel, taking care that it covers the important subjects of the image in order that it will be possible to determine the filter combination quickly and certainly. The unfiltered and marked field of the mosaic filter must always be placed at the top left-hand corner when enlarging, or at the top right-hand corner when contact printing, and the edge of the filter marked with the white strip must face the operator. The print through the

Yellow-Magenta Y

000000	200000	400000	600000	800000	990000
002000	202000	402000	602000	802000	992000
004000	204000	404000	604000	804000	994000
006000	206000	406000	606000	806000	996000
008000	208000	408000	608000	808000	998000
009900	209900	409900	609900	809900	999900

Agfacolor Positive Film and Paper

Mosaic-print

M

Yellow-Cyan Y

000000	200000	400000	600000	800000	990000
000020	200020	400020	600020	800020	990020
000040	200040	400040	600040	800040	990040
000060	200060	400060	600060	800060	990060
000080	200060	400080	600080	800080	990080
000099	200099	400099	600099	800099	990099

C

Magenta-Cyan M

000000	002000	004000	006000	008000	009900
000020	002020	004020	006020	008020	009920
000040	002040	004040	006040	008040	009940
000060	002060	004060	006060	008060	009960
000080	002080	004080	006080	008080	009980
000099	002099	004099	006099	008099	009999

C

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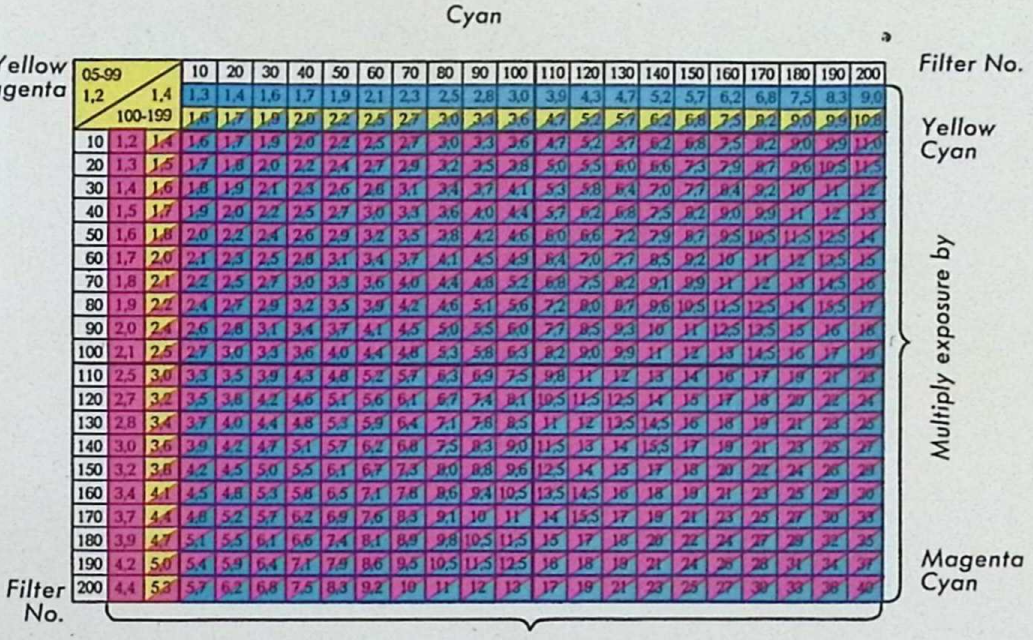
Fig. 56
Exposure meter "Majosix" for enlargments made by "Gossen" Erlangen.

mosaic filter is given twice the exposure which is indicated as correct by the test strip. This increase in exposure will compensate, on the average, for the light absorbed by the fields of the mosaic filter. Since the 36 different filter combinations of the mosaic filter appear repeated up to eight times in the mosaic print, the mosaic filter mask may be used on the developed print and the correct printing filter combination determined. (Cf. fig. 28.)

The arrangement of the mosaic filter, in which fields with the same filtering are repeated in several parts of the print, makes it simpler to determine the correct printing filter, while the probability that the filter combination chosen is the correct one is greatly increased. The process of choosing the filter combination is best carried out by choosing the particular filter field, in an important part of the image, which appears to show a "neutral" color reproduction. The mask is then laid on the mosaic print so that the fields with this filtering alone appear through the holes cut in it. It will now usually be apparent by comparison with the other fields whether or not the first choice of filter combination was correct, or whether some other combination may give even better prints. Once the filter combination is chosen, the correct printing filters are placed in the light-path of the printer or enlager, and the final print made.



If none of the fields of the mosaic print shows a truly neutral color reproduction, it is necessary to estimate between two adjacent fields, and it will be found that with continued experience this necessary estimation becomes more and more reliable. At the same time, it must be remembered that the Agfacolor Mosaic filter is merely a simple guide, and it must not be assumed that it will invariably produce perfect results however intelligently it is used. The cast may be so strong, for instance, that filters of more than 99 color units are required to deal with it, and such a situation may be dealt with by adding the 99-unit filter of the color required to the printer or enlarger, and then making a further mosaic print. If this is done, all the fields of the mosaic filter which have the same color as the 99-unit filter will be increased in value by 100 color units, so that the 20-unit field will be 120 units. By using such methods as this kind practically any really strong cast can be dealt with, and it is only necessary when evaluating the mosaic print later on to remember to add the 100 color units on to the actual field units chosen as correct.

2. b: In the place of, or in combination with, the mosaic print, trial prints may also be made with the Colorax, Colormeister, E. K. Strip

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Printer, Hexagonal Mosaic Filter, or Agfacolor Comparator. The various instruction leaflets should be consulted for the individual working methods required by these printing aids.

Final print

3. *The final contact print or enlargement* is now made. (Figs. 27c, 29c, and 30c.) The printing filter combination indicated by or estimated from the mosaic print or other printing aids is now put in place, and the exposure of the final print carried out. The presence of the filter, however, will mean that the exposure must be increased over that found to be correct by the test strip in (1) above, and the exposure factor which must be used by any combination of filters is shown in the table above. As a general guide it may be taken that each ten color units of magenta added will increase the exposure by 5 %, while each ten units of blue-green added will increase it by 10 %. The presence of increased units of yellow, however, does not involve any exposure increase. If two filters are used in combination, then the exposure must be further increased by 20 %. These rules are, of course, only rough ones, and should not be used except in an emergency. For exact printing and enlarging the table of exposure factors above should always be used:

When using a filter of one color only, the exposure factor by which the correct exposure from the test strip must be multiplied is given in the row or column immediately under the name of the color in the table. Thus, yellow filters of all densities up to 99 units used alone involve an exposure factor of 1.2; a magenta filter of 40 color units (i. e. 00 40 00) needs a factor of 1.5, and a cyan 70-unit filter (00 00 70) requires a factor of 2.3. In this way, if the original exposure indicated as correct by the test strip were 16 seconds, the use of the 00 00 70 filter would mean that an exposure of $16 \times 2.3 = 36{,}8$ seconds would be required for the final print.

Combinations of filters are dealt with in a similar manner. When the combination 10 20 00 is being used, the exposure factor is found by moving downwards from the yellow square indicating yellow filters only until the horizontal row for the 20-unit magenta filter is reached. The factor value is therefore 1.5. For the combination 00 30 50, one starts at the 30-unit square for magenta on the left, and moves horizontally along until vertically below the 50-unit square in the cyan row, finding the factor to be 2.6.

Filter factor for Varioscope and Seriograph

The filter factors in the table should be increased by 30 % if Agfacolor Paper Hard is used.

If the Varioscope F or Seriograph F with continuous filtering, i. e. without filter drawer, is employed, the special filter factors given in the Tables' Section at the end of this book apply.

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All these exposure factors are applied to the correct exposure determined by the test print when no filters were used. If the correct exposure has been determined for a given filter combination, and it then proves necessary to alter this combination, the new exposure value can be determined roughly by the rule of thumb method of percentages given above. To work more accurately, the known correct exposure at the unwanted filtering is converted back to the correct exposure for an unfiltered print — using the table to find the exposure factor for the unwanted filtering, and dividing the correct exposure at this filtering by the factor found — and then redetermining the exposure factor for the corrected filter combination and multiplying the unfiltered correct exposure by it. As an example: the correct exposure for 00 30 70 filters is known to be 19 seconds, but it is required to use instead the filters 00 50 70. The table shows the filter factor for 00 30 70 to be 3.1, and dividing the known exposure of 19 seconds by 3.1 the correct unfiltered exposure is found to be 6.3 seconds. For the filtering 00 50 70, however, the exposure factor is 3.5, so that by multiplying 3.5 by 6.3 we have 21.5 seconds exposure for the new combination of filters. Those who are practised in mathematics will probably make this calculation in an even simpler manner: divide the factor for the new filter combination (3.5) by the factor for the original unwanted combination (3.1), and then multiply the correct exposure for the unwanted combination by the result.

Thus — $\frac{3.5}{3.1} = 1.11 \quad 1.11 \times 19 = 21.5$ seconds.

For rapid work on these lines the slide-rule or disc-shaped slide-rules as well as the Agfa Filter Computing wheel may be used, while at the back of this book are given tables from which the increased exposure times can be read off directly.

As has been explained above, the function of the printing filter is that of correcting the color balance of the print and removing color-casts. In carrying out this correction, however, it is possible from time to time to over-correct, with the result that the cast changes from its original color to the complementary of that color. A magenta cast becomes a green one, while a yellow one turns blue. This general over-correction is conveniently described as "over-filtering" the print.

Overfiltering

Where over-filtering occurs, the rule that the correction filter is the same color as the cast is naturally not valid, for the new cast has appeared because of excessive color in the printing filter and the color units of this filter require to be reduced. An original negative

Agfacolor Positive Film and Paper

showing a magenta cast, for example, requires a magenta filter to make it "neutral", but on using the 00 80 00 printing filter the print turns out to have a green flush instead. In this case, one would not add further yellow and cyan filters (e. g. 20 00 20) but would reduce the magenta filter to 00 70 00 or even 00 60 00.

If, instead of making this reduction, further filters such as 20 00 20 were added, the total filtering effect would be 20 80 20, and since the superimposition of all three filter colors is equivalent to adding a neutral grey filter, the effect would be equivalent to using a neutral grey filter of 20 20 20 in combination with a magenta filter of 00 60 00. The effect of adding the yellow and cyan filters to the original magenta one would thus be the same as reducing the color density of the magenta filter and increasing the printing or enlarging exposure needed.

The above sequence of operations may appear at first to be rather a roundabout one, but — particularly for beginners in the process — it does at least ensure certainty and success. It has already been remarked that after some experience a shortened sequence of operations may be used, and particularly that (1), the making of a test strip to determine the printing or enlarging exposure, can often be dispensed with, which means that (2) and (3) alone result in a final "neutral" print. The printing exposure, too, may be measured by means of barrier-type photo-cell connected to a calibrated galvanometer. The "Majosix" (makers: — Messrs. Gossen & Co. G.m.b.H., Erlangen) is an instrument specially designed for this. (Cf. p. 128. The special instructions for the use of this exposuremeter should be followed). Nor is it necassary to produce a trial print of each individual exposure; a trial print of a negative most typical of ar related exposure series is quite sufficient. All the negatives of this series may then be exposed through the same filter combination.

Number oi the emulsion

In large-scale processing and printing, matters may be greatly simplified by noting the batch number of the emulsion, which is marked on the leader strip of miniature negative films, punched into the end of roll-films, and printed at equal distances next to the frame number along the perforated edge of a miniature film and of a roll-film (Cf. p. 119). Since the behaviour of a given emulsion batch is only very slightly altered by working conditions, a given batch number of negative printing on a given batch number of Agfacolor Paper will require practically constant filtering in printing, so that where films of identical batch number are printed it is often possible to dispense with the mosaic print in a large number of cases. A test strip with the standard filter combination for that emulsion batch will show at once wheter the

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conditions are correct, or whether variations in exposure conditions, slight variations in processing, or differences in the age of the emulsions prior to exposure will make a change in filtering desirable. It has been found in practice that the method of determining printing filters by reference principally to the so-called neutral-filtering by means of both the emulsion number of the negative and of the paper batch is exceedingly helpful. (See pages 119 to 130.)

On the other hand, it may be accepted that in the foreseeable future it will rarely be possible to make a correct "neutral" print without some previous test, so that on the whole it is necessary to consider a mosaic print necessary before the final one can be printed. It is thus very important to record systematically the exposure time and filter combination in pencil on the back of the print before starting to process it, for unless an accurate record of its treatment is available, any correction which may prove to be necessary when it is examined cannot be applied without waste of time and — probably — still another test print. Such records are particularly important where the process is worked on a large scale.

Color temperature of light

To conclude this description of printing or enlarging, it must be made clear that the test strip, the mosaic print and the final print from a given Agfacolor negative must all be exposed in the same printer or enlarger. Every exposing device has its own particular color temperature of light, which varies with the color and age of the paint inside it, the design of the optical system it uses, and the actual lamp which emits the light. It is thus exceedingly difficult to adjust a number of printers or enlargers so that they have identically the same color temperature. Even a change in the enlargement scale or the alteration of the lens aperture used may cause variations in the filter combination needed to obtain a "neutral" print, for the Schwarzschild reciprocity law varies in its effect in the three emulsion layers of Agfacolor papers. This well-known law states that a short exposure at high intensity of light does not necessarily give the same result as a long exposure at a correspondingly reduced light intensity, and since the deviation from strict proportionality varies in the three emulsions of the positive material the result is clearly not only a density variation but also one of color reproduction.

The judgement of the test prints, when determining the correct printing filter, should be carried out in daylight. Judgement in this light quality will give Agfacolor prints which appear correct in half-watt light as well as daylight, whereas the determining of the printing filter by examining the mosaic print in half-watt light gives much less satisfactory results. Yet daylight itself varies in color

Agfacolor Positive Film and Paper

quality quite materially from day to day, so that the ideal would be an artificial light of average daylight quality.

Artificial daylight

Up to the present the most satisfactory approximation to this ideal available is the tubular fluorescent Osram lamp, but certain precautions in its use are essential. It is essential that this light is not mixed with daylight in the judging room, so that the latter must be a dark-room in that no daylight enters it. Furthermore, the persons making the judgement must be in the fluorescent light only for at least ten minutes before proceeding to work in order that he has become acclimatised to it. Where daylight penetrates the room, or the staff judging mosaic prints are moving rapidly from daylight to fluorescent light, trouble must be expected, for the change from one illuminant to the other confuses the judgement and accurate determinations cannot be made.

It is also important that the judging room shall not contain strong colors, either in furnishings or as wall coverings. The walls are preferably painted neutral grey or white, and any colored desks, chairs and the like must be out of visual range when judgements are being made.

The lamps should be about one metre (40 inches) from the working plane, and should be shaded so that they do not strike the eye directly. The rest of the room is also preferably illuminated to a moderate level with the same type of lamp.

Defects of color vision

It is also important to recall, when considering the judgement of colors, that quite a considerable proportion of human beings suffer from serious defects of color vision: the most recent investigations put the figures at 10 % for men and 0.5 % for women. Those with defective color discrimination of this kind cannot be expected to assess mosaic prints correctly for the printing filter combination needed, so that anyone who is entrusted with this work should first be tested by an oculist to make certain that they are physically capable of distinguishing all colors accurately.

Prints and Enlargements on Agfacolor Paper Hard

Production of Prints and Enlargements on Agfacolor Paper Hard

During the production of prints or enlargements on Agfacolor Paper Hard it should be borne in mind that, as in the case of monochrome paper, its exposure latitude is narrower than that of normal paper. This small exposure latitude not only has its effect on the exposure proper, but also on the change in the color cast through the printing filters. Consequently, in most cases the decimal divisions of the printing filters will be too coarse. It is therefore advisable to work with 05-divisions.

Development of Prints on Agfacolor Reversal Copying Film

Prints on Agfacolor Reversal Copying Film

The production of prints from original transparencies on reversal copying film is the task of special processing stations only. Hence, a detailed description of the working procedure is unnecessary in this context. Basically it is similar to the processing of Agfacolor Reversal Cut Film. During exposure, the printing filter colours called for by the various color casts of fig. 26a should be taken into account.

Development of Prints on Agfacolor Positive Film and Paper

Development of prints on Agfacolor Positive Film and Paper

Since exact adherence to the processing instructions is just as necessary for Agfacolor positive material as for Agfacolor negatives, the usual methods of judgement used in developing monochrome material cannot be used, and the production of Agfacolor prints is thus a matter of organisation — or even of engineering — rather than of photography. Since the processing time cannot be reduced to less than thirty minutes from the end of exposure to the moment when examination of the result is possible, it is not practical in large-scale production for the printing staff to expose and develop as well. The two operations of printing and processing must thus be separated and carried out by separate sections of the staff, the increased working costs of the method being compensated by an increase in output per person employed.

For these reasons, large-scale establishments will find it desirable to use the mechanical methods of negative processing, such as tanks, developing baskets, and so on for the positive process, while smaller plants will use the more usual methods of dish development. All vessels and equipment used must naturally not be affected by the solutions used, and porcelain, glass, glazed earthenware, plastic or stainless steel must be used for them. Enamelled steel may be used so long as the vitreous enamel is not chipped and has an undamaged surface.

The production flow should be organised in large plants in such a way that while mosaic test prints are being processed, final prints of previously-assessed negatives are made, so that in general mosaic prints and final prints will be exposed alternately.

The illumination in the processing room must naturally be from the No. 166 Agfa safelight filter, just as in the printing room. A special color developer is essential for Agfacolor positive material, and this, as well as the materials for the other baths used, is available from Agfa Leverkusen in dry form to be made up as required. The

Agfacolor Positive Film and Paper

instructions in each case are enclosed in the package, and it must be noted that the chemicals used for Agfacolor Positive film are not the same as those for Agfacolor Paper, so that they must not be confused with one another. Nor must they be confused with the solutions used for negative material.

When making up the solution, it is preferable to use separate vessels for each solution: if this is impossible, then the vessels must be made chemically clean after using for one solution and before making up another. The tanks, dishes, and so on must be regidly reserved for one type of solution only and not used indiscriminately and successively for different baths. Agfacolor positives should, as with monochrome positives, be developed as soon as possible after exposure.

Agfacolor Positive Film

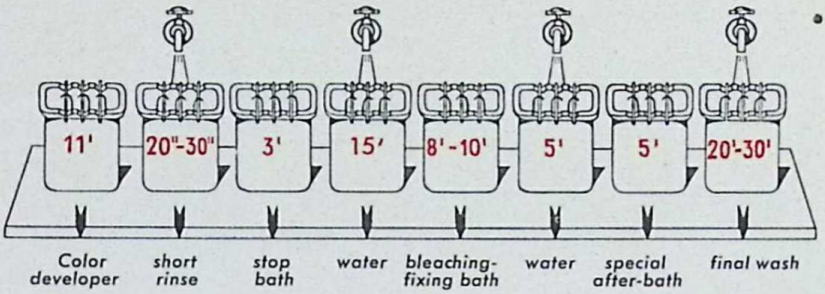
Agfacolor Positive Film

The processing of Agfacolor Positive Film is carried out as follows: — (Fig. 57):

Agfacolor Developer for Negative and Positive Film	11 mins. at 65° F.
Short rinse	ca. 20—30 secs.
Agfacolor Positive Stop-bath	3 mins. at 62—68° F.
First wash (thorough)	15 mins.
Agfacolor Bleaching-Fixing Bath for Positive film and Paper	8-10 mins. at 65—68° F.
Second wash	5 mins.
Agfacolor Special After-bath for Positive Film	5 mins. at 65—68° F.
Final wash (thorough)	20—30 mins.

Color development in the Agfa Color Developer for Agfacolor Negative and Positive Film is stopped by the positive stop-bath. The Bleaching-Fixing Bath converts the black image silver into a soluble silver compound at the same time as it removes the residual silver bromide from the emulsion layers. Also, the intensity of the cyan dye is slightly reduced, resulting in a reddish hue when the films emerge from the bleaching-fixing bath. The subsequent special After-bath restores the cyan dye to is full intensity. Agfacolor transparencies processed according to the above working method can only be judged after the special After-bath.

The yield of 1 L of each of the processing solutions for Agfacolor Positive Film is as follows: —



Agfacolor Positive Film Paper

Fig. 57
Processing sequence for Positive Film

	Width 35 mm	61.5 mm	Cut film 9×12
Agfacolor Developer for Positive and Negative Film	10 m	5 m	24 sheets
Agfacolor Stop-bath for Positive Film	20 m	10 m	60 sheets
Agfacolor Bleaching-Fixing Bath for Positive Film and Paper	20 m	10 m	60 sheets
Agfacolor Special After-bath for Positive Film	20 m	10 m	60 sheets

Agfacolor Paper

Either processing sequence set out below is possible, and may be chosen for the processing of Agfacolor Paper (Figs. 58).

A.

Operation:	Time of Treatment:		Temperature:
Agfacolor Paper Developer	3—6	*minutes	18° C (65° F)
First wash (thorough)	10	„	—
Agfacolor Paper Stop Bath	5	„	16—20° C (60—68° F)
Second wash	3	„	—
Agfacolor Paper Bleaching Bath	3	„	16—20° C (60—68° F)
Third wash	3	„	—
Agfacolor Paper Fixing Bath	3	„	16—20° C (60—68° F)
Final wash (thorough)	20—30	„	
Agfacolor Anti-fading bath	5	„	16—20° C
Drying			(60—68° F)

* The time of development depends on the brilliance required in the image (see p. 151).

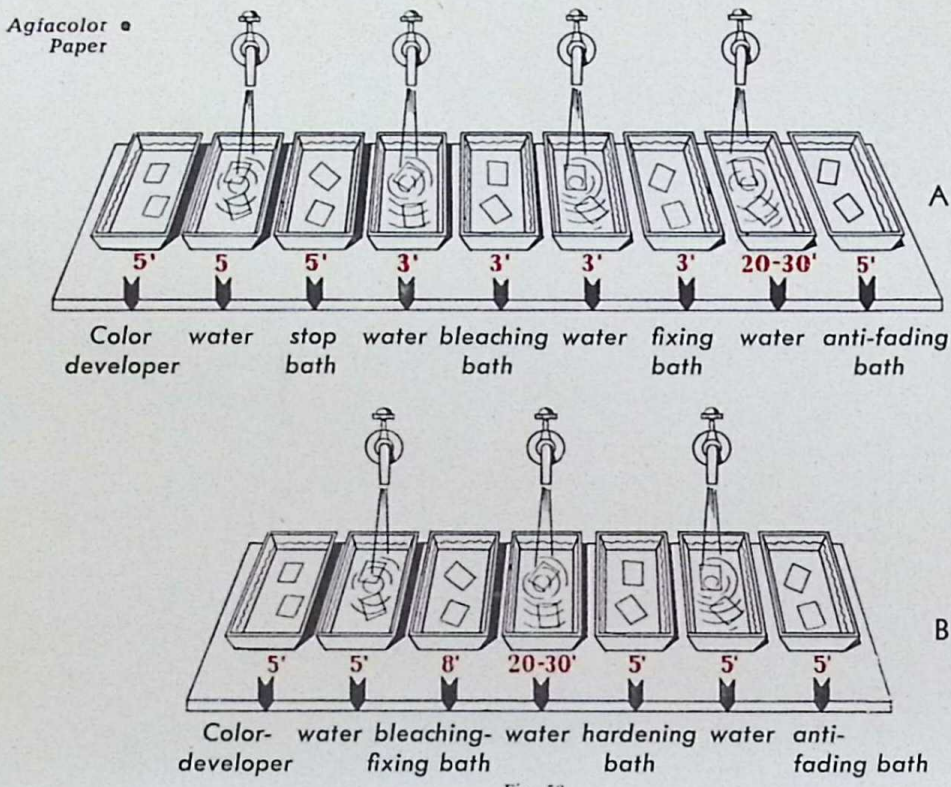


Fig. 58
Processing sequence A and B for Agfacolor Paper

B.

Operation:	Time of Treatment:	
Agfacolor Paper Developer	3—6 *minutes	18° C (65° F)
First wash (thorough)	5 „	
Agfcaolor Bleaching-Fixing Bath for Positive film and Paper	8—15 „	16—20° C 60—68° F)
Second wash	10 „	

At this step, filter tests may (after 10 minutes the paper may be exposed to daylight) be judged. If final prints are to be made, a

Total wash of	20	minutes is given, followed by:
Agfacolor Paper Hardening Bath	5	„
Third wash	5	„
Agfacolor Anti-fading bath Drying	5	„

* The time of development depends on the brilliance required in the image (see p. 151).

Agfacolor Paper

Both processing methods produce results of equally high quality. If they are used side by side, the only difference will be found in the filtering units of the neutral pictures from the same negatives. This difference in the filtering is of the order of a few units, however, and always remains constant. The advantage of the bleaching-fixing bath method consists, apart from a slightly shorter processing time, mainly in the reduced number of baths to be applied in darkness, a particularly favourable factor in the production of large-size paper prints. Furthermore, the whites of the paper-prints will be brighter. In principle, bleaching-fixing bath processing is also possible with Agfacolor Negative Film. Since, however, the results are not so certain as for Agfacolor Positive film and paper, the use of this bath for Negative film cannot be recommended.

The emulsions of Agfacolor Paper are only hardened during the course of processing, and during the development process they are very tender and susceptible to mechanical abrasion. For this reason the use of tanks or paper baskets is desirable in large-scale work. After the paper has been dried after processing, however, the emulsions have been hardened sufficiently to stand up to all ordinary handling.

In the various operations of processing, the following points should be noted.

Color Development

Color Development

This process develops the silver image exposed in the three emulsions layers during printing, and also the oxidation products of development react with the color formers in the emulsions to produce the three dye-images.

It is desirable to make up the color developer twelve hours before it is wanted, and to let it mature before use in tightly stoppered brown glass bottles. Under these storage conditions it will keep two or three weeks before deteriorating. Color developer is highly sensitive to atmospheric oxidation, and it is therefore important not to stir it up vigorously and dissolve air in it, or to allow air-bubbles to form when making it up. The development temperature must be strictly kept to 18° C. (64° F.) under all circumstances, but the temperature of the other baths may be allowed to vary between 16 and 20° C. (60 and 68° F.). Strong cooling of the developer in the winter months, and local simmering by the use of an immersion heater, are both deleterious in effect on a color developer, so that the room temperature should be kept as constant as possible at all times.

Each litre (35 fl. oz.) of color developer will treat some 50 sheets of 9 × 12 cm (1/4 plate) paper or this equivalent in other sizes. A

Agfacolor Paper

stale and over-used developer will give weak and pale images, and even if a dish of the solution has not developed its full number of prints at the end of the day's work, it should be thrown away since it will be stale and oxidised next morning.

Color developer is very sensitive to contamination by traces of the other solutions, and the same adherence to chemical cleanliness is necessary when using it as was described in relation to the negative process.

Regenerator for Agfacolor Agfacolor Paper

Regenerator for Agfacolor Paper Developer

As has been noted above, Agfacolor paper developer will only deal with a certain area of emulsion, and once this limit is exceeded, the images rapidly lose contrast and density. Instead of discarding the developer at this point, it is possible to use the regenerator method described for use with negative materials. This method is only possible where a tank of developer is used, an it is not recommended for use with open dish development, since in this latter case it is more satisfactory to discard developer when it is worn out. The process of regeneration is similar to that used for negatives: the volume of solution taken out on the prints is made up with regenerator solution until the tank is at its original level, and a mark on the inside of the tank is necessary to indicate the original height of solution. When the regenerator is correctly used, the life of the developer in the tank can be increased from 50 9× 12 cm (1/4-plate) prints to 200 9 × 12 cm (1/4 plate) prints, or from half a square metre of emulsion to two square metres of emulsion. When this point is reached, however, further regeneration is impossible, and the solution must be thrown away and fresh developer made up. Moreover, if the total possible. emulsion area has not been developed after 3 to 4 weeks, the developer must in any case be discarded and fresh made up.

A specially simple means of adding regenerator automatically to the tank has been described on page 111.

The regenerator solution must never be used alone as a developer, since it only works correctly in conjunction with the chemicals that remain in the tank.

Developer control

Developer control

As in the case of the negative developer, it is desirable to control the positive developer during use. This is simplest carried out by using a series of prints from one negative that have been given identical exposures, and are then put through the developer before work starts each morning. It is important not to expose a dozen sheets of paper on the test negative and put them

into stock for development on successive days: consistent results can only be obtained if each test print is exposed on the standard negative just before it is developed. A comparison of the prints developed on successive days will give a good indication of the condition of the developer and will avoid having to scrap and repeat printing that is of poor quality because of the developer becoming stale or over-used. The condition of the other solutions may be controlled in a similar manner.

Agfacolor Paper

Development latitude

Agfacolor Paper and Agfacolor Positive film have, like all other photographic materials, a certain amount of development latitude. Within this range, the longer times of development result in an increase in contrast of the image as compared with the shorter times. This quality may be turned to account where the negatives to be printed are under-exposed, or slightly less exposed than correct, since in this case the normal development time for the print tends to give a pale and "smoky" image. Increasing the print development time to 4, or in extreme cases 6, minutes will compensate for this to some extent by increasing the brilliance and contrast if Agfacolor hard is not used. For correctly exposed negatives, however, a standard print development time of 5 minutes should always be used.

Development latitude

Where the development time for the print exceeds the normal time, it is essential that the test strip, the mosaic print and the final print all receive the same increased time of development.

Magnesium sulphate bath

It may happen in practice that in areas where the tap-water is very soft, emulsions of the print may float off or show air-bubbles when transferred from the color developer to the first washing water. This may also occur where the temperatures of the two baths differ considerably. Apart from avoiding temperature variations of this kind between baths, the print should be given 2 to 3 minutes treatment, after development and before the first wash, in a 2 % solution of magnesium sulphate. The magnesium sulphate bath will treat the same number of prints as does the developer: one litre (35 fl. oz.) will suffice for each 50 9 × 12 cm (1/4 Plate) prints or the corresponding area of material in other sizes. The high chlorine content of most tap-water at the present time has no effect whatever on Agfacolor processing.

Magnesium Sulphate bath

Agfacolor Paper

First Wash

First Wash

As with Agfacolor negative material, development does not stop in the Agfacolor print until the first wash has removed all the developing agent from the three emulsion layers. To accelerate this removal of developer, the prints should not be allowed to lie quietly in the washing tank, but should be kept in continuous motion. The Agfa Print Washer is a suitable means of achieving this result in practice, and no attempt should be made to economise on washing water.

Agfacolor Paper Stop Bath

Agfacolor Paper Stop Bath

Development is finally arrested in the stop bath, and it also has the effect of making the image appear stronger and clearer. Since it is particularly fatal to the color developer to be contaminated by the stop bath, it is essential to avoid the presence of the solution either in the color developer proper or in the first washing water.

The stop bath will treat approximately 100 9 × 12 cm (1/4 plate) prints per litre (35 fl. oz.): when it is worn out the result is blue-green fog on the print, so that all prints should be kept in movement in the bath.

Second wash

Second wash

The purpose of this operation is to remove the stop bath from the emulsions of the Agfacolor print.

Agfacolor Paper Bleaching Bath

Agfacolor Paper Bleaching Bath

In this bath the yellow-brown filter layer below the topmost emulsion of Agfacolor Paper ist bleached colorless, and at the same time the metallic silver of the image is converted into a soluble silver salt. The fresh bath has a yellow color, and once the hue tends towards green the bath must be thrown away and replaced by a fresh one. As soon as the prints are immersed in the bleaching bath, the white light can be turned on, and the rest of the process carried out in this light.

The bleaching bath will treat some 300 to 500 sheets of 9 × 12 cm (1/4 plate) Agfacolor paper per litre (35 fl. oz.), and when the time taken to bleach out the filter layer in the prints is longer than one minute, the bath is worn out and must be replaced by a fresh one. The bleaching solution should be stored in brown glass bottles, preferably in the dark, since it is sensitive to light.

Third wash

Third Wash

It is important that the bleaching bath is not carried over by the print into the fixing bath, so that the third wash must be carried out thoroughly.

Agfacolor Paper Fixing Bath

Agfacolor Paper Fixing Bath

In the fixing bath, both the unexposed and undeveloper silver bromide and the soluble silver salt which has replaced the metallic silver image in the bleaching bath are removed. The formula used is not that used for monochrome photography, and only the Agfacolor Positive Fixing Bath will give satisfactory results.

Each litre of fixing bath (35 fl. oz.) will fix out some 300 9 × 12 cm (1/4 plate) sheets of paper. Any slight clouding of the solution during use may be disregarded.

Bleaching-Fixing Bath

Bleaching-Fixing Bath

The Bleaching-Fixing Bath used in working sequence B for Agfacolor Paper fulfils in one step tasks of three solutions necessary in working sequence A: — Stop bath, bleaching bath, fixing bath. It bleaches the silver reduced during color development, at the same time removing all the silver compounds from the emulsion, leaving the pure dye-image behind. The same bath is also used in the processing of Agfacolor Positive Film. The yield of the bleaching-fixing bath is 1.5 sq. m of Agfacolor paper (e. g. 150 sheets of 9×12 or 133 post cards ($3^1/_2 \times 5^1/_2$)) per litre of solution. Exhaustion of the bath is indicated if the deep blacks in the picture acquire a metallic, rust-colored sheen.

The bleaching-fixing bath is strongly reactive with iron-containing alloys with the exception of stainless steel. Only non-metals (plastics, glass, china) should therefore be used for vessels, and V2A or V4A respectively for vessels and tongs.

Regeneration of the Bleaching-fixing Bath for Positive film and Paper

Regeneration of the Bleaching-fixing Bath for Positive Film and Paper

During the use of the bleaching-fixing bath, a change in its composition may occur in two ways: —

1) a reduction of its acid level
2) a decrease in the concentration of its chemicals due to water carried in.

Both changes have an adverse effect upon the final result. If the acidity is too low, the energy of the bleaching-fixing bath is reduced, and too high an acidity leads to a strong red discoloration of the negatives. Insufficient concentration of chemicals is recognized by a green sheen on the back of films. It is therefore most important that both properties of the Universal Bleaching-fixing Bath should be subjected to running control during its use.

The bleaching-fixing bath indicator paper is for use in controlling the degree of acidity. Basically it is nothing but an indicator paper

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such as used in chemical analysis. Its properties, however, are specially adapted for the bleaching-fixing bath. To check the acid level, the indicator paper is moistened with bleaching - fixing bath by a short immersion, or, better still, by placing a few drops of bleaching-fixing bath on it when dry. The moist indicator paper is placed on a whithe support, and its color change observed after 10—20 seconds. It should be yellow or at least grey-green. If it is blue-green or altogether blue, the acid content of the bleaching-fixing bath is too low, and must be increased by the addition of bleaching-fixing bath regenerator (a color chart is enclosed with the indicator paper; its left-hand side shows the color of the indicator paper with correct acid content, and the right-hand side with reduced acid content).

If by means of the Agfacolor Bleaching-fixing Bath Indicator Paper insufficient acidity of the bleaching-fixing bath has been established 3 g of Agfacolor Bleaching-fixing Bath Regenerator per litre of bleaching-fixing bath should be added to the bleaching-fixing bath, with stirring. The regenerator is dissolved immediately in the bleaching-fixing bath. After this treatment, the bleaching-fixing bath, should cause a grey-green to yellow color to appear on the Agfacolor Bleaching-fixing Bath Indicator Paper. If in exceptional cases a blue-grey or altogether blue discoloration should persist on the Agfacolor Bleaching-fixing Bath Indicator Paper, up to 6 g of Agfacolor Bleaching-fixing Bath Regenerator may be added per litre bleaching-fixing bath.

The packet of Agfacolor Bleaching-fixing Bath Regenerator contains 150 g and is sufficient for 50 L of used bleaching-fixing bath.

If the back of a film has a green sheen, or if the blacks on Agfacolor Paper prints show a metallic lustre, it is safe to assume that the concentration of the bleaching-fixing bath has become diluted due to water carried in. In addition to this control, the concentration of the Universal Bleaching-fixing Bath may be found by means of the bleaching-fixing bath testing rod (only for tank processing advisable). This testing rod is slowly immersed in the bleaching-fixing bath (a temperature of 65—68° F should be maintained), where it should fleat freely. According to the degree of concentration of the bleaching-fixing bath, four boundary cases as illustrated below may arise: —

The rod is immersed up to the lower edge of the broad white band: —

The bleaching-fixing bath has the correct initial concentration.

The rod is immersed up to the upper edge of the broad white band: —

The bleaching-fixing bath still works satisfactorily; it is, however, advisable to add bleaching-fixing bath chemicals sufficient for one quarter of the tank contents according to the directions given below (i. e. add chemicals to make 10 L of bleaching-fixing bath to 40 L of used bleaching-fixing bath).

The rod is immersed up to the narrow white band: —

The bleaching-fixing bath works satisfactorily at extended processing times only. It should be regenerated with chemicals sufficient for half the tank contents (i. e. chemicals for 20 L should be added to 40 L of bleaching-fixing bath).

If the rod is immersed with the narrow white band below solution level: —

The bath should be renewed.

The concentration of the bleaching-fixing bath is adjusted with the chemicals from the standard bleaching-fixing bath packet. Addition of the bleaching-fixing bath chemicals to the used bleaching-fixing bath should not take place according to the instructions for the preparation of fresh bleaching-fixing bath. The following directions should be observed: —

Part A of the packet is dissolved in boiling water, stirring;

quantity to make	35 fl. oz.	1 1/8	2 1/4 gallons
volume of water to be dissolved in	120	600	1200 ml.

These volumes of boiling water must strictly adhered to; if the volume is insufficient, part A will not be completely dissolved; if it is excessive, the desired concentration will not be reached.

The boiling solution is added to the bleaching-fixing bath causing a few degrees' rise in temperature, which is without significance. This is followed by the addition to the bleaching-fixing bath of the chemicals contained in part B of the packet. Stirred, they will dissolve after 2—3 minutes. After cooling to 65—68°F, the bleaching-fixing bath is ready for further use. This testing and regenerating procedure is only advisable with tank processing. With processing in dishes, fresh baths should be used.

A falling-off in the energy of the bleaching-fixing bath may also be caused by precipitation of chemicals from the solution at very low temperatures. In this case the deposit must be re-dissolved. The bath should be heated gently to about 90—100°F, stirring con-

Agfacolor Paper tinuously, as local overheating may lead to a decomposition of the bath. Special working instructions describing the procedure are enclosed with the individual packets of bleaching - fixing bath indicator paper, -regenerator, and -testing rod.

Agfacolor Paper Hardening Bath

Agfacolor Paper Hardening Bath

The use of the Agfacolor Paper Hardening Bath is essential with working sequence B. This bath serves to harden the Agfacolor print, and in addition, has further important functions to fulfil. The hardening bath makes it possible to heat dry and glaze the paper print (temperature of the glazing machine not exceeding 70—80° C, 160—175° F.), in most cases without the addition of formalin tho the subsequent antifading bath.

If certain paper emulsions are not sufficiently hardened by the bath, formalin in the concentration stated below should be added to the antifading bath. The hardening bath is designed to work with Agfacolor Paper only. 1 L solution is sufficient for 3 sq. m of Agfacolor Paper or 300 sheets 9×12 cm or 200 post cards ($3^1/_2 \times 5^1/_2$).

Final wash *Final wash*

Since the keeping qualities of the print depend on all the processing chemicals being removed from the gelatine emulsions, it is essential that the final wash is an effective one. A test is possible to make certain that it is adequate, by the following method. A 1 % solution of silver nitrate (which must be kept in a dark-brown glass bottle) is applied on cotton wool — a very small quantity is needed — to the white edge of the Agfacolor print from the washing tank. If a yellow or brown stain develops within sixty seconds time, then the washing has been inadequate and must be continued. If, however, the stain only develops after a longer time-interval, then washing has been adequate. (The same washing test is useful in monochrome photographic papers.)

Wetting agent *Wetting agent*

After washing and before drying, it is useful to bathe the prints for 30 seconds or so in a dilute solution of wetting agent, the prints being then hung up to dry without a further rinse in plain water. This treatment removes all chance of water-drops remaining on them, and it is recommended that the Agfa Agepon wetting agent is used for this purpose.

Agfacolor Anti-fading agent and Drying

Agfacolor Anti-fading agent and Drying

Light-fastness and keeping qualities of Agfacolor Paper will be considerably improved by the use of the Agfacolor Anti-fading Bath.

Agfacolor Paper

The completely processed Agfacolor prints are immersed in the anti-fading bath for 5 minutes after their final rinse and wiping-down. Prints which have already been dried may also be treated in this solution. Dishes made of glass or plastics (no metal except 2VA Steel) are to be preferred. Frequent agitation of the prints in the solution is recommended, as they have to be thoroughly soaked. Following this bath, the pictures are dried at room temperature without another rinse (cf. following paragraph). The finish of the prints is not affected by anti-fading treatment.

"The light-resistance of Agfacolor prints is considerably improved by their treatment in anti-fading solution, although they will not be absolutely fast. They should therefore not be exposed to direct sunlight or strong daylight for any length of time. On the other hand, a general use of the Agfacolor Anti-fading Bath with all Agfacolor Paper prints is urgently recommended. Agfacolor Positive Film, too, may be treated with this anti-fading bath, becoming more light-resistant; its keeping qualities will be improved.

Drying with hot drums

Treatment with the anti-fading agent alone does not protect the prints against the heat of the drying drum. If a glossy finish is to be produced in a dryer-glazer, the Agfacolor prints should be hardened as they are immersed into the anti-fading bath. To 1 L of working solution of anti-fading agent 40—50cc of a 30 % formalin solution should be added, or corresponding volumes at other concentrations. Treatment in the formalin-anti-fading bath is in no way different to that already described. The prints go straight into the normal glazing machine without any further rinse. As the aprons gradually take up anti-fading solution, the use of a second apron is recommended; the aprons should be washed regulary. If a glossy finish is not desired, heat-drying is possible with a very soft cloth only, otherwise the surface texture of the apron will be imprinted on the print surface.

When the dried prints leave the glazer, they should not be stacked in piles, but spread out on a cold support for cooling. After some time the papers uncurl and will lie perfectly flat. This procedure is a well-known part of the black-and-white technique. Especially during the winter in heated rooms, the tendency of the prints to curling is very strong. In particularly dry rooms it is wise to place dishes filled with water, or damp cloths, on the radiators.

Drying at room temperature

If prints treated in anti-fading solution are to be dried at room temperature, they should be placed, emulsion side downwords, on a drying frame over which a smooth, loosely-woven cloth or hardened

Agfacolor Paper

filter-paper has been stretched. They are smoothed-down with filter-paper which should remain in position until they are completely dry.

This process can be accelerated by the use of a strong, dry air-stream whose temperature should not exceed 70°C (160°F.).

To obtain perfect flatness, the prints should be removed from the drying frame before they are bone-dry, i. e. while they are still a little limp, and placed in a pre-heated drying press for a short time. Only a few seconds are required. Completely dry Agfacolor prints, too, may be flattened in a heated press. Time of treatment approximately 3 minutes at 70°C (160°F.).

In the antifading solution some 150 9 × 12 cm (1/4 plate) prints can be treated per litre (35 fl. oz.) of solution. Because of the progressive dilution, and because of dust falling into the dish from the air of the room, it is unwise to carry economy of the solution too far, and for solutions containing formaldehyde, which slowly evaporates from the dish, it is important to keep it in a well corked bottle when not in actual use.

The solution contains no chemicals of a noxious kind, although as long exposure to formalin will harden the human skin it is desirable to use a clean pair of print forceps when working with it.

Color retouching of prints treated by anti-fading solution requires special dyes, as mentioned below under retouching.

Quantities treated by Agfacolor Paper processing baths

Quantities treated by Agfacolor Paper processing baths.

The quantity of material that the above baths will treat is recapitulated in the following table for convenient reference.

Solution:	Sheets 9×12 cm (1/4 plate) paper	Square metres of emulsion
Agfacolor Paper Developer	50	1/2
Agfacolor Paper Stop Bath	100	1
Agfacolor Paper Bleaching Bath	300-500	3-5
Agfacolor Paper Fixing Bath	300	3
Agfacolor Bleaching-Fixing Bath	150	1.5
Agfacolor Paper Hardening Bath	300	3
Agfacolor Anti-fading Bath	150	1.5

Alteration of the print surface

Alteration of the print surface

Although Agfacolor Paper is at present only available in a glossy surface, this may be altered by suitable treatment. Glazing can be done as usual, except that the prints on the glazing sheets

must not be dried by heat, but allowed to dry naturally at room temperature. Matt or grained surfaces may be obtained by squeegeeing into contact with a metal plate of suitable surface structure (plates of other materials can naturally also be used) and then allowing the print to dry naturally. *Agfacolor Paper*

A particularly even matt surface can be obtained by using a clean and dry ground-glass sheet which has been rubbed lightly over uniformly with talcum powder, and the excess of talcum removed by flapping the sheet with a clean dry cloth. The ground glass is now thoroughly wetted by agitation under the water surface, and the wet print squeegeed into contact with it. The ground glass must be treated with talcum for each print.

Glasses etched to a matt surface with hydrofluoric acid are very effective for this purpose: sand-blasted ground glasses with very rough surfaces give unsatisfactory results. Alteration of the print surface by these means is impossible after the print has been treated with Agfacolor anti-fading solution. If it is desired to retain both qualities simultaneously, the washed print is first squeegeed into contact with the matt surface and allowed to dry. It may then be treated with anti-fading solution and dried at room temperature, and most of the matt appearance of the surface will be retained when dry.

Mounting Agfacolor prints

Mounting Agfacolor prints

It is recommended that mounting tissue is used for this purpose, but any reliable photographic mounting adhesive may be used if so desired. The mount color for Agfacolor prints is preferably neutral: various shades of grey may be used to suit the character of the print, or perhaps brown or beige. Mounts of pronounced color are liable to cause unsatisfactory effects because of the contrast they have with the image colors.

Retouching

Retouching

Agfacolor Negatives and Agfacolor paper prints may be retouched, but it is important to distinguish between mere spotting and the retouching of colors. In the negatives, all forms of color retouching should be avoided as far as possible, for it is only possible to know the effect of retouching dyes on the print color after a very great deal of experience and practice. This is because the positive material and not the eye is the arbiter of the retouched effect, and the two "see" the negative very differently. For lightening shadows, and spotting, in the negatives, only pencil and mattolein should be used. Where a defect in the emulsion appears which would

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print black, it is made as dense as possible with the retouching pencil so that it prints white. The white patch on the print is then quite easily touched up with color. Where extensive areas must be retouched, it is useful to carry these out on a separate sheet of film (e. g. matt portrait film) and then print or enlarge the negative and its retouched mask in register. By such means alterations can be carried out at will without any risk to a possibly valuable color negative.

With prints, dye retouching is always preferable to pencil work. The knife cannot be used, since this would remove one or more layers of emulsion and result in colored spots. The following dyes are recommended for the work:

Pelikan photo-colors for glossy prints Type 116. No. 1 Carmine, No. 3 Golden-yellow, No. 13 Ultramarine. A diluting medium is available where soft shades are necessary.

These dyes are made by Günter Wagner, Hannover (20a), Podbielskistr. 92.

The same firm produces retouching dyes for "normal papers dried at room temperature", No. 1 Carmine, No. 18 Orange and No. 6 Prussian Blue being the appropriate hues for Agfacolor prints.

Hoechst Agfacolor Positive Retouching Dyes. K 209 Sky Blue, K 215 Violet (Note: this color is not known as violet outside Germany, but is called deep magenta) und 209 Golden Yellow.

These dyes are made by Farbwerke Hoechst, (16) Frankfurt/Main-Hoechst.

In all dye retouching it is essential never to let the dyes dry on the pallette, but to take freshly from the bottle every time.

Gradation of Agfacolor Paper

Gradation of Agfacolor Paper

When Agfacolor Paper first appeared on the market, only the normal gradation was available to the user. Since 1952, a second grade, Agfacolor Paper Hard, is supplied. This means a considerable improvement in the range of Agfacolor Negative-Positive Processing. The normal Agfacolor Paper ensures an average color brilliance in Agfacolor prints from normal, i. e. correctly exposed and developed negatives. The use of the hard Agfacolor Paper is indicated with flat, under-exposed, or under-developed negatives. It is particularly suited to the reproduction of line-drawings, advertising matter, etc., where increased color-luminosity is required rather than pictorial effect. With pictorial subjects, however, the temptation of increased color saturation of the hard paper might spoil their general effect;

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a

Fig. 59
Monochrome prints from Agfacolor negatives
(See fig. 27c, Plate VII; fig. 29c, Plate XI and fig. 30c, Plate XV)
(See Fig. 27 c, Plate VII; Fig. 29 c, Plate XI and Fig. 30 c, Plate XV)

there is the danger of burnt-out highlights and black shadows destroying their pictorial character. Hence, the most suitable paper grade both from the point of view of picture gradation *and* color brilliance should be chosen for a positive print.

Further, the contrast of an Agfacolor print may be increased by prolonged paper development. On the other hand, a negative of excessive contrast does not call for a paper development of less than 3 minutes; a diluted paper developer should be used at a normal time of development. The paper developer should be diluted with water at a ratio of 2:1 or 1:1 according to the desired results. Even if the developing time is changed and the developer diluted, trial prints and final prints should be processed at identical developing times to ensure valid comparisons.

Hopelessly under-exposed negatives will not yield acceptable prints even with Agfacolor Paper Hard. They should therefore be used for the production of monochrome images.

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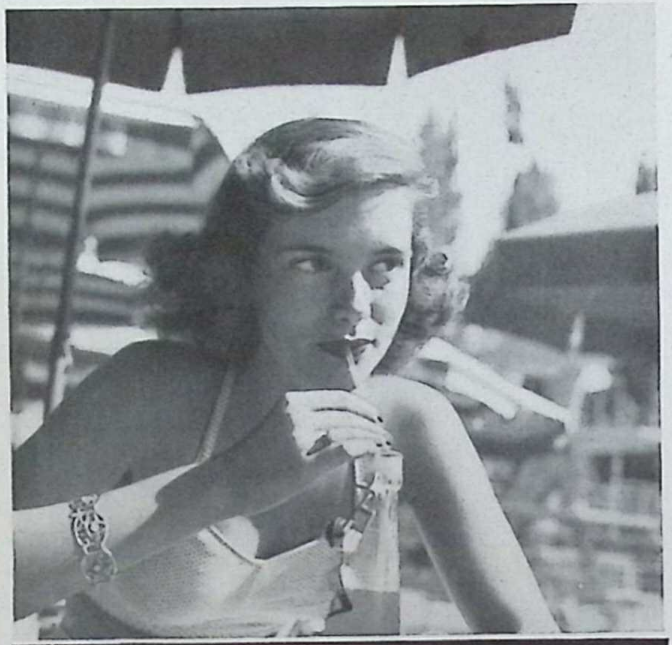

b

c

Using a suitable contrast grade of Agfa Lupex or Brovira paper, such underexposed negatives will usually give very satisfactory monochrome prints. *Agfacolor Paper*

Monochrome prints from Agfacolor negatives

In printing in monochrome from Agfacolor negatives, it is necessary in theory to use a panchromatically sensitive paper if a good tone reproduction of colors is to result. In practice, however, very satisfactory prints are obtained by printing in contact on Agfa Lupex or enlarging on Agfa Brovira papers. This process is strongly recommended for badly underexposed color negatives, which will not give an acceptable color print, and it may also prove useful at other times. The portraitist, for example, may find monochrome prints useful when choosing the most satisfactory out of a series of exposures, before proceeding to the making of full color prints. *Monochrome prints from Agfacolor negatives*

Variations between batches of negative and positive emulsion, and changing from one batch of paper to another, Basic Number, Neutral Value *Changing from one batch of paper to another*

All film or paper manufactured in one batch is marked with its own batch number, and all deliveries with the same batch number have the same constant reproduction of colors and require the same printing filter. The purpose of marking batch numbers on the leader of miniature films and on the end of a roll-film, and, in addition printing of batch members along the edges of the Negative films at regular intervals is to simplify the choice of printing filters by supplying means of identifying the batch of material involved.

Although Agfa are constantly striving to iron out the slight differences in batches which occur at present, it does not appear probable that they will ever be entirely removed. Even in monochrome films and papers certain batch variations occur in regard to sensitivity and contrast, and the physical and chemical nature of the photographic emulsion is such that they are always liable to occur. In Agfacolor material, three emulsions are simultaneously involved, and since each of the three may show the batch variations of a monochrome material, it is clear that the color reproduction of batches must vary slightly, which means that each batch will demand slightly different printing filters.

The color balance of a negative is affected by two factors — apart, of course, from variations in development contrast — the batch character of the negative emulsions and the exposure conditions of the subject. In positive film or paper, on the other hand, standard conditions of exposure are used for printing, so that batch effects

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Batch number

are more strongly marked, but again they will only be obvious where a single negative is printed on different batches of paper. Where the batch number of the printing paper or the positive film is changed, therefore, slight changes of printing filter will be needed.

Basic filter value

To simplify the determination of printing filters, each box of Agfacolor paper is delivered with o basic filter value marked on the outside of the box. This value is in the usual six-figure code, and it represents the filter which must be used over the standard lamp in the Agfa laboratory in order to produce a neutral grey print on the paper batch involved when a neutral grey image is used for a negative.

Hence, the basic number merely indicates the primary color cast of the individual paper emulsion. It is therefore not an indication of quality. In all circumstances, Agfacolor Papers will produce good Agfacolor prints regardless of their basic numbers, provided the appropriate printing filters are used and negatives and papers are processed correctly. To print an Agfacolor negative on Agfacolor paper with a certain basic number, this basic number will only very rarely be the one exclusively determining the printing filter combination; on the one hand, the color of the light of the instrument used by Agfa to determine the basic number will almost certainly differ from that of most printers and enlargers. On the other hand, the color negative film itself frequently has a color cast of its own, which might be expressed as the "Film Basic Number". In addition to the "Paper Basic Numer", both these values, i. e. negative basic number and instrument factor, determine the printing filter combination of the final, optimal print. The influence of the instrument factor can be eliminated by determining the basic number of the paper used in the user's own printer or enlarger. Any monochrome negative with as wide a brightness range as possible is suitable for use. It is printed on Agfacolor Paper, which is color-developed. The resulting color cast corresponds to the basic number of the paper combined with the instrument factor. The appropriate printing filters are inserted to produce a neutral print of the black-and-white negative; it should resemble as closely as possible a print on normal monochrome paper, although it was printed on Agfacolor Paper and underwent color-development. The filter combination required to achieve this effect is called the "neutral value" of the emulsion batch in question in the printing equipment used.

Neutral value

The instrument factor is found by subtracting the basic number of the paper from the neutral value. Generally, however, this is quite unnecessary, since it is better to expose the first trial print through the neutral value combination straight away instead of first making

a zero-print (cf. p. 126). In many cases, the result will be much closer to the final print than the zero-print would be, as the former merely requires the removal of the negative color cast. This, however, is mostly less than the neutral value and will thus be a considerable help in the determination of the printing filters. Further, to the more experienced worker, the basic number or the neutral value constitute means to determine the printing filters with relatively greater ease and a wider range than would be possible with the procedure described on pp. 126 using zero-print, mosaic print, etc. This is the so-called "Filtering by Table" method.

The 5 or 6 values enumerated below are required with this method; they should be tabulated for easy reference.

a) Emulsion batch number of the negative
b) Emulsion batch number of the Agfacolor Paper used for printing
c) Optimal final filter combination of a negative from the emulsion batch a) when printed on paper with the emulsion batch number b)
d) Basic number of the paper used } or d) neutral value of the
e) Factor of the instrument used } paper used = d) + e)
f) or e' respectively: basic number of the negative film found by subtracting the neutral value from the optimal final filter combination (f(e') = c — d))

It will be clear from these facts that all negatives with the emulsion number of (a), when printed on paper from batch number (b), can be given, without previous work of any kind, the standard batch filtering (c) in printing or enlarging, in the full expectation that many of the first prints will be of acceptable quality, and quite a good proportion of excellent quality. Even in the cases where the first print is unacceptable, the skilled man judging filter values will have no difficulty in altering the printing filter to get an excellent result in the second print, for the difference between the used filter combination and the optimal combination will be quite small.

The method has a wider use than this, however, for we have shown that the printing filter actually required is found by adding the paper basic filter value or neutral value to the basic filter value for the negative emulsion. There is thus no difficulty involved in changing from one paper batch to another so long as the negative basic filter value has been found previously: the basic filter value for the old paper batch is replaced by that for the new paper batch, and nothing further needs to be done. If slight variations appear as a

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result of the change, they will readily be corrected by these who are judging trial prints and determining filter combinations.

The only assumption involved in this filter-table method is that the same printing box or enlarger is used all the time, since each instrument has its own color value. In the filter-table, the instrument factor appears combined with the negative emulsion factor in the basic filter factor for the negative material.

The method is simplest understood by a series of worked examples, as below. For the sake of clarity, only the basic number will be mentioned. However, this may be replaced quite easily by the neutral value, if this has been determined by the user. Therefore (neutral value) will be found printed after each "Basic Number of the Paper" in the examples.

Example 1.

a) For an Agfacolor negative "I", used with
b) Agfacolor Paper batch "A"
d) Basic filter value (neutral value) 002030
c) Filtering for neutral prints proved to be 007060. By subtraction of c — d
e) Basic filter value of negative is 005030.

For practical convenience, this would be tabulated as —

a) Negative "I"
b) Paper "A"
c) Paper value (neutral volue) 002030
d) Neutral filter I/A 007060
e) Negative value 005030.

Example 2.

For a negative of emulsion batch "II" the same batch of Agfacolor paper "A" required a filter combination of 200030
for a neutral print. By subtracting the paper value (neutral value) 002030
the negative value will result, but subtraction is not immediately possible here. Since any combination of three filters with equal values is a neutral grey tone, however, and does not alter the color, we can add a grey tone of 202020
to the filter combination for neutral prints, and obtain 402050
from which the paper value 002030
can be subtracted without trouble, leaving 400020
The negative value for emulsion "II" on the table is thus 400020

Example 3. *Agfacolor Paper*

Negative emulsion "III" with Agfacolor Paper batch "A" having basic filter value 002030
requires a filter combination 507000
to give neutral prints. Here, too, subtraction is not immediately possible, so that 303030
must be added to the filter combination, thus giving 8010030
From this we may subtract 002030
and obtain the basic filter value 808000
for negatives of batch "III".

If a new batch of Agfacolor paper "B" comes into use with these negatives, with the different basic filter value 403000 it is only necessary to use this new basic value (neutral value) and add it to the negative basic values, to obtain the printing filter combination suitable for the new conditions.

Example 4.

Negative emulsion "I", with basic filter value 005030 (see example 1 above) is used with paper of "B" batch, having basic filter value (neutral value) 403000.

Adding the two basic factors:	005030
	+ 403000
New filter combination will be	408030

But this filter contains all three colors and thus must embody a neutral grey, so we subtract from it 303030, and obtain 105000 for the printing filter combination I/B.

Example 5.

Negative emulsion "II", basic value	400020	(Example 2)
Paper batch "B", basic value (neutral value)	+ 403000	
Filter combination required is	803020	

which also contains a neutral grey, so on subtracting from it 202020 we obtain 601000 as the printing filter combination II/B.

Example 6.

Negative emulsion "III", basic value	808000
Paper batch "B", basic value (neutral value)	+ 403000
Filter combination required is	12011000

Agfacolor Paper

It will be clear that this simplified method of printing filter determination is only possible if the negative emulsion number is available, so the importance of marking each picture of a roll-film, flat film or miniature film (where the last is cut up) is clear.

The keeping qualities of undeveloped Agfacolor material

The keeping qualities of undeveloped Agfacolor material

All Agfacolor negative material is marked on the carton with the latest date on which it should be processed. After this date has been passed, it must not be expected that satisfactory images will be obtained on it.

After exposure, all Agfacolor material should be processed at the earliest possible moment.

Storage of unprocessed Agfacolor material

Storage of unprocessed Agfacolor material

Agfacolor films and papers should be stored in a cool dry place. The relative humidity should not exceed 40—60 % and the temperature should not be higher than 20° C. (68° F.), but the maximum temperature and a low relative humidity is preferable to a low temperature and a very damp atmosphere. (New buildings are usually both cold and damp.) If Agfacolor material has been stored at a very low temperature, it should be conditioned before exposure by keeping it at room temperature (18° C. = 64° F.) for at least twelve hours.

Use of Agfacolor Films in the Tropics

Use of Agfacolor Films in The Tropics

Although numerous Agfacolor films have yielded excellent results in the past, experience is not wide enough at present to give a general guarantee for the quality of Agfacolor material in the tropics.

From a general point of view the introduction of Agfacolor Films into hot, dry areas (desert climate) is less risky than using them in humid, hot countries (jungle climate) if the following precautions are observed. Even if hints given below are followed, no absolute guarantee can be given for passable results in the case of humid climates. The following points should be observed:

1) It should be made clear on the order that the films are intended for use in the tropics.

2) It is advisable only to take sufficient material for immediate use and to have further supplies forwarded by air mail if possible.

3) Large expeditions are advised to solder approx. one week's supplies of film material into tins in a dry atmosphere in order to maintain normal conditions of humidity as long as possible.

Agfacolor Paper

4) If soldering-in is not possible, the films should be placed in jamjars closed with a rubber ring and clamp. Further, silica gel, or as a stop-gap measure, grains of rice should be introduced into the jars to absorb moisture.

5) It is a particularly important point to leave the film in the camera for as short a period as possible as it is then that it is most exposed to the influence of the climate; also, in most cases conditions will be beyond any control.

6) The exposed film should be stored in jam-jars as under 4), but kept separately from the unexposed material.

7) Immediate return by air mail for processing is recommended.

8) The best storage conditions are obtained in air-conditioned rooms at temperatures between 15 and 25° C (59—77° F.) and a relative humidity not exceeding 65 %. In an emergency, a normal refrigerator or even an ice-box will be sufficient, but it will be necessary to store the films in sealed containers (see para 4) together with hygroscopic substances (silica gel, rice grains) to avoid the formation of water of condensaction at low temperatures.

9) Wrapping paper intended for use with material to be returned or stored should be thorougly dried out beforehand.

10) Agfacolor transparencies to be introduced into the tropics should be framed in a dry atmosphere in Agfacolor Transparency Frames (Filmosto) which exclude the surrounding air to a large extent.

Storage of processed Agfacolor negatives

Storage of processed Agfacolor negatives

Processed negative material requires the same storage conditions as the unprocessed.

The developed Agfacolor negatives are preferably cut and should be kept in the usual bags. If clear, transparent foil is used, however, unfavourable effects will sometimes occur. This material may contain softeners and glycerin which attract moisture. This affects the negatives, causing their deterioration, Hence, these bags should be tested, or different material such as pergamine paper etc. be used. The emulsion batch number should be written on these bags, although the negative strips are already marked with their batch numbers during manufacture.

However, developed films may also be stored in the usual aluminium tins in which they are supplied. A strip of tissue paper is wound up with them to prevent scratches. This method of storage ensures continuity of negatives with the same emulsion batch number, and facilitates filter determination (see p. 151).

Agfacolor Paper

In very moist and hot conditions (e. g. tropical climates) there is a serious risk that bacteria or mould will attack the gelatine of the image and cause marks which cannot be removed later. Where it is known that there is a risk of this form of attack, it is useful to treat the negatives or transparencies with a 0.2 % solution of sodium pentachlorphenate (2 grams of the compound to a litre of water, or 18 grains per 20 fl. oz. Pentachlorphenol sodium is obtainable from Agfa Leverkusen) for three minutes, and then to dry without washing. Particularly valuable negatives may be given this treatment as a precaution even where the risks are slight.

Permanence of Agfacolor dye images

Permanence of Agfacolor dye images

The dye images of Agfacolor material are as permanent as it is possible to make them. But since color development is restricted in its choice of dyestuffs to a very limited range, it must not be expected that the image colors have the permanence of the developed textile dyes or of inorganic pigments. Although, therefore, the dyes have been chosen to be as permanent as is compatible with the other demands of the Agfacolor process, they should not be exposed for long periods of time to daylight, and particularly to sunlight. The result of such exposure is that the colors fade, just as nearly all other dyes do under the same conditions. Negatives should therefore be stored in boxes or opaque envelopes and wallets, while Agfacolor prints should be kept in an album. A very material increase in both the general keeping qualities of the Agfacolor images and transparencies and their fastness to light is obtained by treatment with Agfacolor anti-fading solution as described on page 145, and it is strongly recommended that this treatment is given to all Agfacolor positive images.

Agfacolor images are also sensitive to very damp conditions, and these should be avoided. If the above points are observed, the dye-images of Agfacolor material remain permanent over very long periods indeed.

Physiological effects of processing chemicals

Physiological effects of processing chemicals

The earliest developing agents used in color developers — and they are still largely used — have the unpleasant quality of causing eczema in many people who come in contact with them. Because of the importance of this matter, a great deal of work has been done on the subject by Agfa, and it has proved possible to use developing agents which have proved over years of use not to have any such effect on normal people. There are, however, certain people who are known to be sensitive to developing agents of ordinary kinds, such

as metol, which causes them to have dermatitis, and it may thus happen that even the improved developing agents used in the Agfacolor process may give trouble in isolated cases. Where this occurs, the sufferer should not personally use color developers of any kind. *Agfacolor Paper*

The other chemicals used in Agfacolor processing do not differ in their physiological effects from those used in ordinary monochrome photography. They may thus be used under the same measures of cleanliness as the latter without further consideration.

Cleaning the Hands. *Cleaning the Hands*

Those who do not use rubber gloves or developing forceps when processing Agfacolor materials will frequently find that their hands are strongly stained brown. The stain may be removed by treatment with bleaching powder solution or potassium permanganate solution. Where permanganate solution is used, the hands must afterwards be bathed in potassium metabisulphite solution to remove the permanganate stain. After drying the hands, they should be rubbed well with a fatty-base ointment. It is undesirable to use this method too often, since the chemicals involved attack the skin to some extent.

H. Practice of Masking

I. Production of grey masks.

Grey (silver) masks

A) Normal grey masks (silver masks) (cf. Section C, p 55 and Fig. 39).

A contrasty color picture always shows a higher color saturation than a soft picture. One is therefore inclined to neglect the fact that the tonal separation is too great for the sake of this increased color saturation. By using a monochrome mask, the contrast of such a strongly saturated color print may be lessened without impairing the high color saturation; in other words, color prints showing normal, satisfactory picture gradation inspite of high color saturation are obtained. It should be borne in mind, though, that masks may reduce the exposure latitude of the color film a little, and that they depend upon a good color balance, because any tendency to color cast is naturally emphasized by a higher degree of color saturation. If color filters are used during the production of grey masks, their effect will be limited to brightness changes in the colors compared with the grey mask without a filter. Neither grey masks, nor the use of color filters in their preparation result in a change of color hues.

The following working method should be adopted for the production and use of grey masks:

1) The developed Agfacolor Negative is printed, emulsion side facing emulsion side, on a panchromatic monochrome film (Agfa Isopan Portrait matt, Agfa Isopan F matt).

2) The exposure is made through Agfacolor Printing Filter 990000 (yellow), or, preferably, through Agfa Repro Filter 5 (yellow). The mask should receive a generous exposure.

3) The mask is given a *black and white* development in Agfa Atomal for 6—8 minutes or Agfa 14 for 3—4 minutes at 65° F. to a gamma of .4—.5. The result is a very flat, dense positive without contrast, the grey mask.

4) The mask is bound *back-to-back* together with the Agfacolor Negative. As a first step, the two films are joined along one of their longitudinal edges by means of a transparent adhesive strip (adhesive tape). After the register is checked on the printing surface of a printing box, the other longitudinal edges are also joined with adhesive tape. This back-to-back arrangement of the films has the affect of slight diffusion and suppresses small errors in the registration. In the case of original negatives on miniature film, the mask is prepared on perforated monochrome miniature film (Isopan F). The perforation holes facilitate registration. Faulty registration of the masks causes an undesirable relief effect in the print; moderately unsharp masks, however, will yield sharp prints. Hence the back-to-back position of mask and color negative.

5) The film-sandwich color negative + mask is inserted in the enlarger or printing machine with the emulsion side of the Agfacolor negative facing the paper, and exposed on Agfacolor Paper. The exposure time through the mask is approximately 5—10 times that of the exposure without the mask. The picture is, as usual, given a neutral balance with the aid of the printing filters. Practically the filter combination remains unchanged compared with a neutral print made from the same negative without a mask.

The required gradation of the paper depends on the quality of the color negative. Normally developed (6—7 minutes) Agfacolor negatives require Agfacolor Paper Hard, with Agfacolor negatives which had received more contrasty development (longer, 10—12 minutes), Agfacolor Paper Normal is used. Only in special cases, where picture gradation may be neglected, the contrasty Agfacolor negative with mask may be used in conjunction with Agfacolor Paper Hard, in the interest of increased color saturation. In every instance, prints are obtained which show considerably more saturated colors than would be achieved with a normal color negative without grey mask.

Grey masks having the same gradation as the negatives

B) Grey masks having the same gradation as the negatives.

Agfa Isopan F Film is used for the production of grey masks with the same — but opposite — gradation as the original negative (cf. Fig. 40) and developed in Agfa 71 for 5—6 minutes at 65°F. (see formula below). Exposure and use of the mask is the same as described under I A). The negative + mask combination should be without gradation and without contrast in transmitted light; if this requirement is not met, development of the mask was either too long or too short. Prints on Agfacolor Paper Normal or Hard give

pictures without gradation or differences in brightness, with very luminous, saturated colors.

C) Grey masks with excess gradation.

Grey masks with excess gradation

Agfa Isopan F Film is used for the production of grey maskes having a steeper — but opposite — gradation than the original color negative (cf. Fig. 41), and developed in Agfa 71 for 10—12 minutes, at 65° F. (see formula below). The excess-gradation grey mask is made and used like the normal grey mask (cf. Section I. A). In the print, however the very steep positive gradation of the grey mask has a stronger effect than the flat gradation of the color negative. Hence, a negative appears on the paper print on Agfacolor Paper Normal or Hard (bright colors in the negative are reproduced dark, dark colors bright), the colors, however, remain positive. This excess-gradation mask should only find use for special effects.

II) Production of paper prints from Agfacolor Reversal originals (transparencies) with the aid of grey masks.

Paper prints from transparencies

The production of colored paper prints from Agfacolor transparencies obviously takes place by way of an intermediate Agfacolor negative. This two-stage copying process (transparency-color negative and color negative-paper) causes an excessive loss of color saturation due to the faulty absorptions of the component dyes. For this reason, the use of a grey mask to increase the color saturation is absolutely essential.

The working procedure for making these grey masks and their use is as follows:

1) A copy is made of the transparency on Isopan F miniature film through Agfa Printing Filter 99/00/00 (yellow) or Agfa Repro Filter 5 (yellow), emulsion side facing emulsion side.

2) The Isopan F film is developed in Agfa Atomal for 8—10 minutes or in Agfa 14 for 6—8 minutes at 65°F. A monochrome negative is obtained.

3) The grey mask is bound back-to-back in register with the Agfacolor transparency (cf. I A).

4) The combination Agfacolor transparency + mask is inserted in the enlarger with the emulsion side of the transparency facing the enlarging board, and exposed on Agfacolor Negative Film K without a filter.

5) The Agfacolor Negative Film K is developed to an color negative according to the normal directions; developing time 10—12 minutes a 65°F.

6) This Agfacolor Negative is printed or enlarged on Agfacolor Paper Normal or Hard, obtaining, as usual, a balanced picture with the aid of the printing filters.

Colored Masks

III) Colored Masks.

In addition to color saturation, color masks also improve faulty color rendering caused by the unwanted secondary color densities of the negative dyes (cf. Section C and Figs. 42—44). The magenta dye above all others shows undesirable effects. Its secondary color density in the blue region of the spectrum renders all blue colors too dark, all the yellows too bright, and green hues are often displaced towards the blue-green. The color masks are based for the purpose of eliminating these faults. Generally, the following rules must be observed:

1) The exposed mask (print) is made from that color layer whose dye shows faulty secondary absorptions (e. g. the magenta dye).

2) The mask is dyed with the color contained in the faulty dye as "false" color (i. e. yellow in the magenta dye).

3) The gradation of the colored mask must be identical with and complementary to that of the secondary color density to be masked.

4) Since the complementary gradation of the colored mask reduced the "primary" color-gradation of the layer of the same color in a multi-layer film (e. g. yellow layer), this loss must be made good through an additional negative of the color in question, having the same gradation as the mask.

Since the main faults in color-rendering are caused by the unwanted absorption of the magenta dye in the blue spectral region (yellow secondary color density), the mask to remove it must be colored yellow.

Hence, according to 1), a print (mask) of the magenta image from the magenta layer must be made, and 2) dyed yellow. Thus the print is exposed to green light (complementary to magenta) onto a green-sensitive material (ortho- or panchromatic). The mask is dyed yellow, resulting in the yellow mask. Compensation for the loss in gradation of the primary yellow (4) caused by the subtraction of the (yellow) secondary color density (in magenta) (effect of the mask) is brought about by a negative dyed yellow, having a gradation identical with that of the mask. For this purpose the yellow image in the yellow layer is printed on blue-sensitive material through a blue filter and developed black-and-white. The monochrome positive

obtained in this way is in turn printed on black-and-white material, and the resulting negative dyed yellow. This compensating negative must have a gradation equal and complementary to the yellow mask. Yellow mask und compensating negative must be bound together in register with the original color negative. The combination of these three films serves as a printing "sandwich" for the final paper prints.

This comparatively cumbersome procedure is simplified in an ingenious way by the production of a "gradationless" yellow corrective combining the yellow mask and the yellow compensating negative in one film. The following method is adopted:

"Gradationless" yellow corrective

1) Production of a print from the Agfacolor negative through a blue filter (Agfa 552) on monochrome film (Agfa Process Film C ortho), emulsion side facing emulsion side.

2) Development of the print to a monochrome positive with Gamma = 1.0. Developer Agfa 71 (see formula below), developing time 3—5 minutes, or Agfa 71 diluted 1:10, 6—10 minutes at 65°F. The choice of the developing time depends on the required Gamma = 1.0.

3) Binding in register of the monochrome blue-filter positive together with the color negative, emulsion side facing emulsion side (use adhesive strip as explained in Section I).

4) Control of the correct blue filter positive gradation: — When the film combination color negative + monochrome positive (blue filter positive) is viewed in transmitted light on a printing box through a green filter Agfa 54, a step-wedge, if present in the negative, must show a continuous area of uniform density. Moreover, all the blue colors in the original (yellow colors in the negative) must show a lower, all the yellow colors in the original (blue colors in the negative) must show a higher density than the area of the step-wedge. If a step-wedge was not incorporated in the color negative, grey tones of the original contained in the negative should be used as control. All the grey tones irrespective of their varying densityes in the original must be of identical density in the film combination. In comparison, blue colors of the original must have a lower, yellow colors a higher density. If this condition is not fulfilled, the blue filter positive must be exchanged accordingly for another with a different gradation. If the condition is met,

5) the film combination is printed onto a monochrome material, preferably the same as under 1) (Agfa Process Film C ortho) through a green filter (Agfa 54). The back of the color negative should face the emulsion side of the process film.

6) This print is developed yellow (see formula below), representing the yellow corrective.

7) Gradation and exposure control of corrective: — The corrective is satisfactory, if the step-wedge area — or, in its absence, all the grey tones of the original — show an identical yellow density in the corrective. It should be of medium strength. Besides, yellow colors of the original should be clear in the corrective, or, at the most, show a very thin yellow veil. On the other hand, all blue colors of the orginal should have a heavier density than the grey tones. The controls described for the yellow and blue tones of the original should be applied all the more closely if no step-wedge was included in the picture. Particular stress is laid on the fact that the colors mentioned refer to the colors of the original, i. e. they must be complementary in the color negative concerned. The density of the corrective should be kept as low as possible to avoid an undue increase in the, exposure time of the print. If a check of the corrective has made it clear that the three conditions described have not been met, the blue filter-separation, still combined with the color negative, must be replaced by one with a different gradation. Differentiation in the step-wedge, or the green and blue colors of the orginial, at once indicate — according to the preponderance in the step-wedge area of the density-run of either the blue filter positive or that of the color negative — whether the blue-filter separation should have a flatter or steeper gradation than the old color separation.

8) Combination of the yellow corrective with the Agfacolor negative. The yellow negative replaces the monochrome blue-filter positive, previously combined with the color negative (adhesive strip etc. see above). The best method to check for accurate register is the use of a light-box with an illuminating surface identical in size with the color negative. A blue filter Agfa 552 is placed on this surface, followed by the color negative, emulsion side downwards; the corrective, emulsion facing the back of the color negative, is carefully brought into register with it. Alternatively, the blue filter may be omitted from the light-box and the assembly checked through a blue filter placed in front of the eye.

9) The film combination Agfacolor negative + corrective serves as a printing "sandwich" for enlarging or printing on Agfacolor Paper Normal or Hard. The combination is inserted in the enlarger as usual, the emulsion side of the color negative facing the printing base.

Correctly made yellow correctives yield color prints with more saturated colors, particularly in the yellow and blue tones, and the

green tones will show less tendency towards blue-green. Accordingly, correctives of different colors may be produced to eliminate the other faults of the dye components (cf. Section C). Since these faults have considerably less effect than the secondary color density of the magenta dye, they are not specially mentioned here in order to avoid confusion.

Formulae:

1) Developer Agfa 14 for the production of grey masks:

Metol	4.5 g	70 gr
Sodium sulphite anh.	85 g	3 ozs 40 gr
Sodium carbonate anh.	1 g	15 gr
Potassium bromide	5 g	75 gr
Water	1000 cc	35 fl. oz.

2) Developer Agfa 71, for the production of contrasty grey masks and monochrome development of the blue-filter separation for the yellow corrective.

Metol	5 g	75 gr
Sodium sulphite anh.	40 g	1 oz 180 gr
Hydroquinone	6 g	90 gr
Potassium carbonate	40 g	1 oz 180 gr
Potassium bromide	3 g	45 gr
Water	1000 cc	35 fl. oz.

Monochrome masks and the blue-filter color separations are correctly exposed if they show good detail in the shadows as well as in the highlights and if an evenly-graduated step-wedge included in the color negative shows evenly-graduated steps over its entire length.

3) Yellow development of the corrective. Development takes place in the normal color developer for Agfacolor Negative and Positive Film made by Agfa, in which 2 g (31 gr) of yellow component (yellow 52/50) are dissolved per litre. (The yellow component can be obtained from Agfa Photofabrik Leverkusen).

Working procedure of yellow development:

Development: —	6 minutes at 65° F.
Rinse	5 „
Agfacolor Negative Fixing Bath	5 „
Rinse	5 „
Agfacolor Negative Bleaching Bath	3—5 „

Note: — White light may be turned on after one minute's bleach.

Rinse	5 minutes
Agfacolor Negative Fixing Bath	5 „
Final rinse	5—10 „

The final rinse should not be extended too long, as the yellow dye produced during development dissolves to a certain extent during

prolonged washing. The strength of the corrective (its "contrast" or gradation) may be influenced within certain limits by varying the color development time, depending on the character of the original subject. A subject with very strong colors requires a "harder" corrective than a subject with less saturated colors, i. e. the corrective should be given longer or shorter development respectively. Very hard correctives with excessive development lead to exaggerated color "improvement", and the prints frequently appear to be of a lower quality than unmasked prints.

In the main, two principles should govern the use of masks or correctives:

1) The use of masks only pays if the additional work involved justifies the costs, i. e. chiefly if a large number of prints from the same negative or publicity material of special value or printing blocks are required.

2) Every masking technique requires special training. In the hands of an experienced and technically skilled photographer, however, it is an excellent means to enhance the color effect.

I. Sources of failure

Although it is true to say that the materials and chemicals for Agfacolor photography are made and tested before despatch with the very greatest care, it is still possible to get bad results with therm. This fact cannot be ascribed to any defect in the process itself: it derives from improper treatment on the part of the user. The ordinary mistakes of monochrome photography, with which most people are now familiar, appear in the Agfacolor process, and have just the same unpleasant effect on the results. These forms of unkindness to the raw material should, therefore, be avoided.

The principal causes of bad results in Agfacolor are failure to follow instructions provided, lack of cleanliness in processing and the use of chemicals or accessories which are unsuited to the Agfacolor process. Among these are the following:

1. Troubles due to incorrect light quality
2. Troubles due to incorrect processing baths, and
3. Troubles caused by the instructions not being followed.

1. Troubles due to incorrect light quality

Troubles due to incorrect light quality

Agfacolor films are made in two different types, "T" for use in daylight and "K" for use in artificial light. The daylight film should not be used in artificial light and the artificial light film should not be used in daylight. Above all things, exposures must never be made with mixtures of lights having different quality, such as daylight and incandescent lamps. To show the reason for this, a simple experiment may be made: a pencil is lit from one side by daylight and from the other side by a half-watt or photoflood lamp. (Cf. fig. 50.) Two shadows will be thrown by the pencil, and observation will show that the shadow thrown from the lamp appears blue by comparison with that thrown from the daylight. This difference in shadow color must of necessity occur, because the pencil stops the light from the lamp reaching the table beyond. This shadow is thus only lit by daylight, which is much higher in blue light content

than the lamp-light, so that it is bluer than its surroundings. The same is true the other shadow thrown from the daylight: it is not lit by daylight, but only by lamp-light, which contains a large quantity of red, and it must necessarily appear red against its surroundings. The Agfacolor film, however, shows colors purely objectively, so that in the print the one shadow is bluish and the other is reddish.

This point must be watched by portrait photographers, since few studios are so blacked-out that they have no daylight whatever penetrating into them, and also because it has often been customary for portrait workers to use mixed daylight and artifical light for exposures. This last cannot be done with Agfacolor, and it is important to make certain that light of only the required quality reaches the subject.

There is, of course, no reason why mixed lighting should not be used for some special effect in the color prints: what is important is that these effects should occur by design and not by mistake.

Unwanted light may also reach the Agfacolor film in another way. Most roll-film cameras have on their back a red window through which the picture number on the backing paper of the film is observed. Light passing through this red window and penetrating the backing paper has already been a source of trouble where very sensitive panchromatic monochrome films are used, and for this reason many modern cameras are fitted with a device by which the window may be covered when it is not in actual use. Where such a cover is not provided, however, it is essential to ensure that direct sunlight does not strike the red window when Agfacolor film is in the camera. Agfacolor films are highly sensitive generally, and the red-sensitive emulsion is nearer to the window than the other two emulsions. Where sunlight strikes the red window for some moments, therefore, there is a serious risk of it reaching and exposing the red-sensitive emulsion of the film. This fogging exposure will develop to a cyan (i. e. minus red) patch in the color developer and the print will show a red patch at this point.

Fogging by the dark-room lamp is a further source of bad results. Agfacolor film is exceptionally sensitive to all colors, and must be processed either in complete darkness or in the light of the No. 170 Agfa safelight filter. Any other dark-room filter will cause fog on the film and result in distorted color reproduction. If a red filter is used, such as the Agfa No. 107, only the red-sensitive emulsion will be fogged, and a heavy cyan fog on the image will result after development. The same dark-room safelight causes a general

red discoloration and fogging with Agfacolor Reversal Film. This type of fog is readily identified since it occurs all over the film, and not just in the picture area alone.

Turning to Agfacolor Paper, the emulsions here are balanced in sensitivity so that they are suited to half-watt type incandescent lamps. When using these last as light sources in printing and enlarging, no trouble need be expected. But if other sources of light are used in printing, such as mercury-vapour lamps in particular, it may perhaps still prove possible to obtain a "neutral" print on Agfacolor Paper from some negatives, but the three emulsions are not balanced for this type of light, and good results will be very difficult to get in most cases, and will not be obtained at all in many.

It is also essential that the test strip, the mosaic print and the final print are all exposed in the same printer or enlarger. Every different printer or enlarger has its own color temperature, so that if the mosaic print is exposed in one, and the final print in another, the filter combination obtained from the mosaic print will be incorrect for the final print. It is only where one instrument is used for all three prints that consistent printing and "neutral" results can be obtained.

It may also be repeated here that it is essential to keep the voltage on the printer or enlarger lamp constant, since any alteration in voltage produces a corresponding change in the color temperature of the emitted light. A reduction in voltage makes the light redder (i. e. color temperature is lowered) while a voltage increase turns the emitted light bluer (a color temperature increase): these differences are recorded by the Agfacolor Paper during exposure and appear as changes in color reproduction in the developed image. If no automatic voltage regulator is available, it is essential to instal a voltmeter and regulating resistance in the lamp circuit, and to watch the voltmeter continuously while the exposure is being given, so that sudden changes can be corrected by the resistance. Where very wide changes in mains voltage are known to take place, it is important here to run the lamp on a voltage lower than the least that is expected from the mains: if this is not done, a sudden drop in mains voltage may be so great that the voltage on the lamp drops beyond the controlling range provided by the resistance.

2. Troubles due to incorrect processing baths

Troubles due to incorrect processing baths

The processing chemicals delivered from the Agfa factory to customers are tested before delivery in the firm's scientific laboratories, and can be regarded as being always reliable, always provided that

they are correctly made up and used according to the instructions on the package. It is out of the question to expect satisfactory results from other chemicals, particularly from those used for ordinary monochrome photography. As an example, Agfa Final developer will certainly produce a silver image in the three emulsions of Agfacolor Negative film, but no dye-image, while it will also not bleach the yellow filter layer under the topmost emulsion. A negative image such as this cannot easily be used even to print monochrome copies, and is of course not a color negative at all. In the same way, a fixing bath of ordinary formula cannot be used successfully on Agfacolor Negative film, and the other Agfacolor processing chemicals must never be permitted to get contaminated by an ordinary acid fixing bath. It is because of this source of trouble that it was recommended above that in all large-scale processing plants, special dark-rooms and work-rooms are set aside exclusively for Agfacolor processing, and that no monochrome photographic work is done in them. Unless this is done, it is certain that sooner or later a mistake will occur in either the safelight filter, the processing solutions, or even in both at once.

It is also just as important to ensure that the baths used for different types of Agfacolor material are kept separate, and only used with the material for which they are designed. Agfacolor negatives must not be developed in Agfacolor Paper Developer, and vice versa, and this general precaution must be extended to the rest of the solutions used in processing. The same applies to Agfacolor Reversal Films and the other processing materials respectively.

Troubles caused by instructions not being followed

3. Troubles caused by instructions not being followed

As has already been stressed in the description of the operations of processing, three essential conditions must be fulfilled if consistently satisfactory results are to be obtained on Agfacolor material. These are —

(a) Strict cleanliness
(b) Correct processing temperatures, and
(c) Correct times of treatment

The troubles resulting if these conditions are unfulfilled may be indicated briefly as follows.

(a) Chemical cleanliness

Anyone whose fingers have been in contact with the stop bath or some other solution, and who then puts them into the color developer to take out the next print without first washing them thoroughly, must not be surprised to find red spots on the prints, or a general

tinting of the whites. It is also true that if the washing processes are not carried out in freely running water, but consist merely of soaking the prints in a dish of stagnant water, the quality of the final prints will be seriously impaired. A dish of stagnant water soons becomes loaded up with the chemicals brought from the preceding bath by the prints, and if they are carried forward to the next operation it cannot be expected that the prints will approach in quality those that have been adequately washed throughout.

Even the dark-room towel may be a source of troubles which prove exceedingly elusive to identify and eliminate. Unless the hands are thoroughly washed before wiping them dry on the towel, the towel itself will become contaminated with all kinds of processing chemicals, and these may later be applied to the hands and thus passed on to the processing solutions actually in use. When this occurs, prints cannot be expected to remain unaffected, so it is essential always to rinse the hands before drying them, and to change the dark-room towel frequently to ensure that it never — even by accident — accumulates chemicals to a serious extent.

(b) The importance of the thermometer

Many dark-rooms posses thermometers, but these remain in their virgin condition in boxes or drawers, and are not hung in the developing tank or laid in the developing dish. It has been noted above that processing temperatures are an essential factor in satisfactory Agfacolor work, and this is especially true of the color development operation. The systematic monochrome photographer who is accustomed to work to the thermometer and the dark-room clock, will find nothing unfamiliar here, but he must note the following point. When the color developer is cold, it naturally develops more slowly than it would at the standard temperature of 18° C. (64° F.), and if monochrome material were being developed, this could be compensated by increasing the time of development. But with color material one is developing three emulsions of very different qualities simultaneously, and the optimum results can only be obtained if the developer is maintained at one standard temperature. It is thus also undesirable to use the color developer at a higher temperature than the standard, and to decrease the time of development to compensate for its more rapid action. When the developer is at such a higher temperature, the results will usually be very strong dye-images, fog, and excessive swelling of the gelatine emulsions, which may even dissolve or separate from one another.

Where an immersion heater must be used in cold weather to warm up the contents of a tank of color developer, it is very important that the heater must be kept in constant movement, in order to ensure that the developer is not over-heated locally. This would have a very had effect on its capacity to develop Agfacolor material.

(c) The dark-room clock

is an essential where complementary colored negatives are being developed and printed. The old rule of the photographic profession, that emulsion are developed until the shadows start to appear on the back of the plate or film, cannot possibly be used for Agfacolor negatives: not only is the image exceedingly difficult to see in the dim light from the No. 170 safelight filter, but also this rule of thumb method is far too erratic to be considered as an exact method. For the operations other than development, and for the washes, the times prescribed are the minimum ones that can be permitted, and on no account should they be cut down. Some increase in them has no effect, but very great increases are deleterious to the image quality.

With Agfacolor Paper, it is possible after a good deal of experience to judge the process of development in some measure under the No. 166 safelight filter. Judgement, however, is limited to the top emulsion and the silver image in it: in so strongly colored a light as is given by the No. 166 safelight no judgement of the colors or the color reproduction is feasible. At the same time — this will be confirmed by observation — development does not stop when the print or negative is removed from developer: the three emulsions continue to develop for some time in the washing water used after development. The appearance of the image in the developer is thus by no means any reliable guide to the final appearance of the print, and in the long run it is much more simple to watch the hand of the clock or to listen for the bell which indicates that the time for development is finished. Moreover, where corrections are necessary, they are made with the same convenience and high accuracy by the clock itself.

The following tables give some guidance to causes of processing faults of Agfacolor Reversal Films. Agfacolor Negative Films, and Agfacolor Paper. If the user is so inclined, he may add to these tables from his own experience, but should guard against generalizations of freak results.

1) Agfacolor Reversal Film

Faults:	Causes:
Pictures are too dark and too dense, blocked highlights, degraded colors with normal rebate density*)	Under-exposure, or first developer too old, exhausted or too cold, or insufficient agitation in first developer
Pictures are too bright with burnt-out highlights, thin, insipid colors at normal rebate density	Over-exposure
As above, but rebate density less dense than normal	Over-development in first developer (too warm or too long development) or color developer exhausted or color development too cold or too short also over-exposure combined with either of the above Insufficient second exposure
Pictures show excessive color contrast and very dense rebate density	Color developer too warm or applied too long
Pictures are too bluegreen, rebate density ligther than normal	Old color emulsion with exceeded expiry date, or incorrect storagee of films (tropics) or too bright and unsafe green dark-room safe-light
As above, but normal rebate density	Use of artifical ligth film in daylight
Pictures yellow-red	Agfacolor daylight film exposed to artificial light Exposures with low sun
Side-reversed reddish-brown pictures of excessive density	Insertion of film with back instead of emulsion side facing the lens, Cut films have a notch at the top righthand corner indicating the emulsion side facing the operator.
Pictures show a deep yellow or yellow-green color	A yellow or green filter was used during exposure. Agfacolor Reversal Film must be used without yellow/green filter

*) Rebate density is the blackening of such parts of the film as the perforation which are unaffected during exposure.

Agfacolor Reversal Film

Faults:	Causes:
Pictures with partly correct, partly incorrect colors	Exposure to mixed light (daylight and artifical) Reflections from colored objects nearby or from the sky
Pictures uniformly red, rebate density normal	Red filter during exposure
Pictures red, with reddish rebate density	Action of red dark-room light before or during first development
Red splashes in the pictures	Effect of acids, e. g. acid fixing bath. Fault may be removed by after-treatment in 5% sodium carbonate solution if acid action had not been too strong or color developer contaminated with fixing bath, or films received splashef of color developer before or during second exposure
Pictures show yellow-to-brown-ish veil or yellow stains	Insufficient bleach (bleaching bath too old and exhausted). Fault can often be removed through second bleach in fresh bleaching solution Insufficient intermediate rinse after color development. No remedy possible
Blank film without traces of picture	Incidence of strong stray light prior to first development. Cause of fault may be faulty insertion, open film slide behind open shutter
Film uniformly black without traces of picture	Film was unexposed, shutter failure. Lens cap left on, or film slide not pulled out. Unexposed film mistaken for exposed film.
Bright, irregular spots and streaks in the picture	Incidence of light through faulty parts of camera
Round or polygonal spots in the picture, frequently near its centre	Reflections of light within the lens during exposure against strong light (use a lens hood)
Transparent or light streaks coming from the margin	Leakage of light trough damaged wrapping Leakage of light through loose winding
Lack of sharpness in the picture	Faulty focussing Lens out of alignment Condensation or dirt on the lens
Longitudinal streaks parallel to the margin	Jammeed guide rollers in the camera Foreign body on film slide etc.

Agfacolor Reversal Film

Faults:	Causes:
Pictures show normal density, colors are somewhat degraded and lack brilliance	Incomplete bleaching, pictures still contain silver; repetition of bleaching and fixing gives improved result
General reddish-brown discoloration, or, with frame development, reddish-brown transverse streaks	Insufficient second exposure of back of film. Cannot be remedied afterwards.
General milky appearance	Inufficient fixing. Second fixing and rinse removes the fault
Reticulation (granular surface structure of the emulsion)	Temperature variations between treatment baths and wash water excessive. Baths too warm Light too hot during second exposure. Distance of 500W lamp to film should not be less than 32".
Irregular scratches	Careless handling of films in solutions Foreign body in chamois leather used for wiping-down
Circular dark spots	Air bubbles on film during first development
White film on emulsion side	Insufficient final wash (fixing salt) washing water too hard (lime deposit)
Circular, light-dark rings	Wetting bath omitted
Deep-brown, uniform fog, without colors in the picture	The film was given negative development in a monochrome developer. The film is completely bleached in the Agfacolor Reversal Bleaching Bath, so that it assumes an over-all milkywithe color. Instead of fixing, the films is now again developed in any monochrome developer, e. g. Agfa Neutol or Agfa "Final". A short rinse, fixing, and final rinse follows. The negatives improved according to this method can be used without difficulty for black-and-white pictures.

2) Agfacolor Negative Film

Agfacolor Negative Film

Faults:	Probable causes:
Negative too thin	Underexposure in the camera; developer too cold; developer too dilute; development time too short.
Negative too flat in contrast	Developer too cold; developer too dilute; development time too short.

Negative too dense	Overexposure in camera; developer too warm; excessive time of development.
Negative too hard in contrast	Developer too warm; excessive time of development.
General red fog in negative	Developer or first washing water is contaminated with fixing bath; first wash too short or omitted.
Uneven or irregular red fog	Exposure to too bright a green safelight in the dark-room
Strong general yellow-brown fog and no color images in the film	Film developed in monochrome developer solution. The fog may be eliminated by using bleaching bath diluted 1:10 with water, then fixing. The bleaching must be observed. The negatives then can still be used for making monochrome prints.
Strong magenta fog	Safelight filter is faulty (probably No. 166 is being used in place of No. 170).
Numerous blue-green patches at one definite point of the picture	The red window in the camera back has been exposed to direct sunlight for too long a time. The red light gives a blue-green (i. e. minus red) image on the developed negative.

Positive Film and Paper

3) Agfacolor Positive Film and Agfacolor Paper

Faults:	Probable causes:
Image flat, pale and "smoky"	Underexposure in the negative. (May be partly compensated by longer print development time or Agfacolor Paper hard.)
Image too thin	Underexposure; under-development; developer too cold; developer too dilute; first wash too short.
Image too dense and dark	Overexposure; over-development; developer too warm.
Red veil or fog	Developer or first washing water is contaminated with stop bath or fixing bath
Red dots or patches	Fixing or stop bath has been scattered over the print.
Blue or green dots or patches	Water drops scattered over the paper before development.
Yellow veil or fog	Insufficient washing after the bleaching bath.
Blue veil or fog	Faulty safelight: the No. 107 or 112 is being used instead of the No. 166.
Violet veil or fog	Faulty safelight: the No. 113 filter is being used instead of the No. 166.

Faults:	Probable causes:
Brown or yellow tint over the whole print area	Bleaching bath either omitted or else the bath used was worn out.
Yellow-reddish veil or fog	Insufficient fixing.
Various print densities from identical exposure times	Variations in mains voltage; irregular development times.
Irregular mottling of the entire print.	Work-out stop bath after development
Matt deposit on print surface	Due either to worn-out fixing bath or to very hard water being used. In the latter case 1/2% acetic acid lightly rubbed over the print on a viscose sponge will remove the deposit. In the former case new prints must be made with a new fixing bath.
Red fog	(1) Developer contaminated with stop bath or fixing bath or bleaching-fixing bath. (2) First washing water mixed with stop bath or fixing bath or bleaching-fixing bath. (3)Stop bath contaminated with developer.
Bronzed, rust-colored shadows	Exhausted bleaching-bath or bleaching fixing bath. Increase bleaching-fixing time or prepare fresh baths. The fault can be removed by repeated bleaching or bleaching-fixing.

K. The fields open Agfacolor photography

While the Agfacolor Reversal film, in spite its excellent results, is comparatively limited in its range of possible use, this is not the case with the Agfacolor negative-positive process. This — the first subtractive color printing process in the world — makes it possible (as has been repeatedly said above) to produce any required number of transparencies or prints in natural colors from a single negative in complementary colors, and thus at one stroke breaks down most of the previous barriers against the use of color materials.

Cinema Films

The film industry, for instance, has now available a process for producing color-films of the highest quality, and any number of release prints. This process, moreover, is handled in practically the same manner as the ordinary monochrome process.

Amateur and professional photography

The amateur and professional photographer are now able to make contact prints or enlargements in color either in their own dark-room, or else to put our the developing and printing of their exposures to processing houses, as is most convenient.

Advertisment

These general fields, however, by no means exhaust the possibilities of the process. Advertising in all its multifarious forms has available in Agfacolor a completely new medium of expression, whether transparencies (for use, for instance, in cinemas) or colored prints on paper are required. The greater effect of a colored advertisment over a monochrome one is already well known, and the Agfacolor process provides an incomparably simpler way of making color prints than has ever been available before. The fact that such color prints are actual objective photographs must not be forgotten: a photograph in this field has proved to be infinitely more compelling than the best of sketches or drawings.

Printing industry

In this connection, the use of Agfacolor in the printing industry must also be spoken of. Agfacolor Reversal film has already brought about considerable changes in technique here, on account of its simplicity in handling: while in former times it was necessary to

make color separation negatives from an original (which has always been a difficult problem technically) the use of Agfacolor Reversal film made it possible to obtain records even of rapidly moving objects in any normal camera. The three separation negatives could then be very simply made from the resulting color transparency. This method, however, still involved a considerable amount of retouching and hand-work, which would preferably be dispensed with by automatic correction processes, and it has been found that the use of Agfacolor negatives in complementary colors results in considerably improved separation images (as compared with the Agfacolor Reversal film) from the point of view of color printing. As a result, the cost of the retouching required is materially reduced, and the whole process cheapened. The Agfacolor negative-positive process is therefore of extreme importance to the printing industry as a technical medium that will improve the quality of results as well as promote economy. It is also advantageous that color prints can be made simply and readily from the color negatives, for they may be used to guide the color-printing process, and are more satisfactory in this respect than color transparencies can ever be.

The Agfacolor Reversal Cut Film may also serve as guidance to the color balance of the print, since it can now be processed by the user himself, and is therefore available before the Agfacolor Paper print. Howewer, two exposures are required: — one on Agfacolor Negative Film, the other on Agfacolor Reversal Film. The Agfacolor negative is preferred for the production of the separation negatives as it ensures maximum separation. The transparency, as already mentioned, merely serves as a guide to the final color rendering.

Instruction

The value of Agfacolor negatives and prints in the realm of pure and applied science must also be pointed out: anyone who has seen the difference between monochrome and color cinema films of surgical operations as used for medical teaching will appreciate how essential color photography is in these fields. Instruction in botany and zoology, as well as in dyeing and painting, are merely casual examples taken at random from the vast possibilities opened up by the Agfacolor process. The same thing is even more true of color prints on papet as compared with ordinary monochrome photographic prints

Science

in every application of teaching or scientific records. While a monochrome print must have its grey tones translated mentally into terms of color, the Agfacolor print shows these colors just as they were in the original, and the better differentation thus given of the various portions of the subject makes the prints more immediately

Educational aid

comprehensible and thus increases their value as an educational aid.

In principle, natural colors are specially valuable in all cases where recognition of the salient features of a scene is important, and the principle is of value to the legal and criminal photographet. Much legal photography consists of representations of the scenes of accidents and the like, and color here may prove to be of very great importance. It is not yet possible to indicate how deeply the Agfacolor process may affect the recording of scientific results, or to say what its ultimate effects in education may finally prove to be.

Criminal photography

A further field of use for the Agfacolor process is that of cartography and aerial photography. Colored aerial photographys by the Agfacolor negative-positive process show up the details of the landscape below much more clearly and separately than the usual monochrome aerial photograph. It may further be used for the determination of contours in landscapes from the air, as well as for the detection of prehistoric earthworks and other remains.

Aerial photography

Although this brief account does not by any means mention every field of possible use for the Agfacolor process, enough has been said for the reader to appreciate the great future possibilities open to this method of reproducing color. It will thus be of great interest to see how it develops as time goes on.

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M. Tables and Directions

1. Exposure times

a) In daylight

Daylight

To determine the correct exposure time an exposure meter * or an Agfa Exposure Table should be used, if possible.

The speed of the Agfacolor films according to the various speed rating systems may be found in the following table.

In case neither exposure meter nor table are available, the following hints will give correct exposure times. —

DIN degrees	A S A Expos. Ind.	General Electr.	Weston No.	Europ. Scheiner degrees	Respective exposure time
9/10	5	—	4,0	19	10
10/10	6	8	5,0	20	8
11/10	8	10	6,4	21	6,4
12/10	10	13	8	22	5
13/10	12	16	10	23	4
14/10	16	20	13	24	3,2
15/10	20	25	16	25	2,5
16/10	25	32	20	26	2,0
17/10	32	40	25	27	1,6
18/10	40	50	32	28	1,2
19/10	50	64	40	29	1,0
20/10	64	80	50	30	0,8
21/10	80	100	64	31	0,64
22/10	100	125	80	32	0,50

* Concerning the standardization of exposure meter with camera and film cf. p. 67.

Reversal Film "T"

a) Agfacolor Reversal Film "T"

Agfacolor Reversal Film "T" at present corresponds to a speed of 15/10⁰ DIN. (13—16 Weston).

May—August between 10 a. m. and 4 p. m., 1/50 sec.

	Full sunlight	Light haze (misty)	Overcast (Dull)
Beaches, mountain scenes	16	11	8
Sunny streets, bright buildings, open landscape with distance	11	8	5,6
People in the open, landscapes with dark foreground, street scenes	8	5,6	4
Dark buildings, persons in the shade	5,6	4	2,8

For exposures at other times the year or day the aperture is to be opened one stop further.

When using electronic or blue-coated flash the aperture must be one stop larger than that determined by the guide number stated for 15/10⁰ DIN and the particular flash equipment used. This method serves the purpose of counteracting the flat front illumination without contrast.

The use of filters for exposures is in all cases unnecessary and undesirable. Only in the case of exposures at high altitudes (above 1500 m — 5000 ft.) a *colorless* U. V. absorption filter may be used to eliminate the effects of the strong ultra-violet light. The appropriate filter to use is Agfa Filter K 29c.

In the case of exposures on reversal film containing little contrast (e. g. in dull weather, fog, or mountain shots with snow) and when used from the location of the camera i. e. from a considerable distance from the subject, the values indicated by exposure meters are too short, because exposures on reversal film must be based on the brightest highlights and not, as with negative film, on the darkest shadows. In such cases the exposure time indicated by the exposure-meter should be increased by 1 1/2 to 2 times, as the reduced contrast would otherwise lead to under-exposure. The above-mentione correction is not necessary if the reading is taken at a short distance, but with reversal film the exposure meter must always be directed at the brightest objects still to show detail.

β) Agfacolor Negative Film "T"

Negative Film "T"

Agfacolor Negative Film "T" at present corresponds to a speed of 13—14/10° DIN. (10—13 Weston).

For exposures between 10 a. m. and 4 p. m. in the months of May to August inclusive, the shutter speed of the camera is set to 1/50th second, and the lens aperture shown in the table below used. (For other times of the year or times of the day, the shutter speed should be 1/25th second, or the next larger aperture to that indicated in the table used.)

	Sun in clear sky	Lightly veiled sun	Partly overcast	Overcast, or under trees when clear sun is shining
Beaches, mountains and snow scenes	f/11	f/8	f/5,6	f/4
Open landscapes, sunny streets, and open squares	f/8	f/5,6	f/4	f/2,8
People in the open, landscapes with foreground, and street scenes*	f/5,6	f/4	f/2,8	f/2
People in the shade or in gardens	f/4	f/2,8	f/2	f/2

* Using this standard lens aperture, satisfactory results will generally be obtained on Agfacolor Negative "T" film. If the lens aperture available does not reach the required value, then the next smaller lens aperture on the scale may be used, and the shutter speed doubled. In general, it is always desirable to give ample exposure in cases es of doubt. Betwen noon and 2 p. m. in summer, the high sun usually throws dark cast-iron shadows under the nose and round the eyes of persons lit by it: portratis under these conditions should be avoided as far as possible.

(b) Artifical light

Artifical light Reversal Film "K"

α) Agfacolor Reversal Film "K"

Agfacolor Reversal Film "K" at present corresponds to a speed of 15/10° DIN. (13—16 Weston).

The same rules apply to the arrangement of nitraphot lamps as with the use of monochrome films. Background illumination and the avoidance of colored reflections from wallpaper are especially to be considered.

Exposure hints with Nitraphot lamps type B, 500 W in aluminium reflectors at f/4.

1 lamp at distance			
2'6"	3'3"	5'	6'6" from subject
Exposure time			
1/10 sec.	1/5 sec.	1/2 sec.	1 sec.

2 lamps at a distance		
2'6" / 4'2"	3'3" / 3'	5' / 8' from subject
1/10 sec.	1/5 sec.	1/2 sec.

If yellow flashbulbs or flash powder are used, the appropriate direction should be used. It should be noted that with a speed of 3/10° DIN below that for which the flash conditions are valid the next-larger stop, i. e. the next-smaller stop-number should be employed. At a difference of 6/10° DIN the aperture should be 2 stop-numbers larger or the distance of the flash should be halved. The use of plain flashbulbs is not recommended. Agfacolor Reversal Film "K" is not suitable for electronic flash.

The use of taking filters is in all instances unnecessary and undesirable.

Negative Film "K"

β) Agfacolor Negative Film "K"

Agfacolor Negative Film "K" at present corresponds to a Speed of 16/10° DIN (16—20 Weston). With luxmeter measurements for Agfacolor Negative Film "K" the following table should be used: —

Stop / Lux	4,5	5,6	8	11	16	22	32	
3000	1/10	1/5	1/2	1	2	4	8	
2000	1/5	1/2	1	2	4	8	16	seconds
1000	1/2	1	2	4	8	16	32	
500	1	2	4	8	16	32	1	
250	2	4	8	16	32	1	2	minuts
100	5	10	20	40	1 1/4	2 1/2	5	
50	10	20	40	1 1/4	2 1/2	5	10	
25	20	40	1 1/4	2 1/2	5	10	20	

The readings will vary within narrow limits according to the make of the luxmeter. Hence, the instrument should be calibrated with camera and film like an exposure meter by means of trial exposures (cf. p. 67).

2. Guide Numbers for various flash light sources used with Agfacolor Film

Flash light Guide numbers

The Guide Number of flash light sources is found according to the formula

Guide Number = Stop Number × Distance in feet

For instance with a guide number of 72, the flash may be used at f/8 at a distance of 9 feet, or at f/5.6 at a distance of 13 feet. The various manufactures state the guide numbers of their respective instruments. The reflector (its shape etc.) may account for differences in the guide numbers of otherwise identical light-sources.

The following rules should be observed:

In the case of *monochrome films* it is better to use one stop larger the guide number (this avoids the need for hard or extra-hard paper during printing).

In the case of *color negative films*, the next-larger stop number must be used if the guide number for the speed of the color negative film has been derived from that given for monochrome film.

The guide numbers are particularly small für *Agfacolor Reserval Film* compared with exposures on Agfacolor Negative Film "T" at least the next-larger stop should be used in order to get correctly exposed tranparencies. Thus, the speed of the Agfacolor Reversal Film is only rated at 5 Weston (10/10° DIN), whereas it is stated to be 16 Weston (15/10° DIN) in daylight.

3. Color temperatures with light sources in degrees Kelvin

Color temperatures

Light source:	Color Temperature:	Film type to be usde:
"Half-watt" lamp, 40 watts	2700°	K
"Half-watt" lamp, 200 watts	2800°	
"Half-watt" lamp, 1000 watts	3000°	
Nitraphot type "B", Photolamp	3200°	
Nitraphot type "S", Photopearl	3300°	
Flash-powder	3300°	
Osram flash-bulb	4700°	T or K
Arc lamp: plain carbons	4700°	
Arc lamp: withe flame carbons	5500°	T
High-intensity arc lamp	5800°	
Sunlight	5800°	
Electronic flash	6500°	

Agfacolor Negative Film and Agfacolor Reversal Film are adjusted to the following color temperatures:

Daylight T	5500° K
Artifical light K	3200° K

Directions For Processing Reversal Film

4. Directions For Processing — a) Agfacolor Reversal Film

		Time (Mins.)	Temperature (° F.)	Yield per 1 (35 fl. oz.)	Keeping Qualities in well-closed tank (floating lid)
In Darkroom (Agfa Film 170)	1.) First Developer (I) for Agfacolor-Reversal Film				
	Tank	32—36	65	3—4 Agfacolor-Reversal Cut films 7¼×9¾" or rollfilms or 35 mm films (36 exposures)	1 week
	Dish	28—36	65	as above	discard after the end of each working day
	2.) Thorough intermediate wash	25	57—68	—	—
In Daylight	3.) Wetting Solution (Agedon 1:200)	1	57—68	10—12 as above	2 weeks
	4.) Second exposure 500 W lamp, 40" distance	5	—	—	—
	5.) Color developer for Agfacolor Reversal Film (II)	11—12	65	6—7 as above	2 weeks
	6.) Thorough intermediate wash	25	57—68	—	—
	7.) Bleaching Bath (III) for Agfacolor Reversal Film	5	65	6—7 as above	2 weeks
	8.) Intermediate wash	5	57—68	—	—
	9.) Fixing Bath (IV)	5	65	6—7 as above	2 weeks
	10.) Intermediate wash	5	57—68	—	—
	11.) Hardening Bath (V) for Agfacolor Reversal Film	5	65	10 as above	2 weeks
	12.) Final wash	20—30	57—68	—	—

b) Agfacolor Negative Film

Negative Film

Operation:	Time:	Temperature:
Agfacolor developer for Negative and Positive Film	6-7 minutes	18° C. (64° F.)
First wash (thorough)	15 minutes	—
Agfacolor bleaching bath for Negative and Positive Film	5 minutes	16-20° C. (60-68° F.)
Second wash	5 minutes	—
Agfacolor fixing bath for Negative and Positive Film	5 minutes	16-20° C. (60-68° F.)
Final wash (thorough)	20 minutes	—

c) Agfacolor Positive Film

Positive Film

Operation:	Time of treatment:	Temperature:
Agfacolor Developer for Negative and Positive Film	11 minutes	18° C. (64° F.)
Brief rinse	20 seconds or so	—
Agfacolor Positive Stop Bath	3 minutes	16-20° C. (60-68° F.)
First wash (thorough)	15 minutes	—
Agfacolor Bleaching-Fixing Bath for Positive Film and Paper	8-10 minutes	10-20° C. (64-68° F.)
Second wash	5 minutes	—
Hardening Bath for Agfacolor Positive Film	5 minutes	10-20° C. (64-68° F.)
Final wash (thorough)	20-30 minutes	—

Agfacolor Paper

d) Agfacolor Paper

Processing Sequence A:

Operation:	Time of Treatment:	Temperature:
Agfacolor Paper Developer	3-6 minutes*	18° C. (64° F.)
First wash (thorough)	10 minutes	—
Agfacolor Paper Stop Bath	5 minutes	16-20° C. (60-68° F.)
Second wash	3 minutes	—
Agfacolor Paper Bleaching Bath	3 minutes	16-20° C. (60-68° F.)
Third wash	3 minutes	—
Agfacolor Paper Fixing Bath	3 minutes	16-20° C. (60-68° F.)
Final wash (thorough)	20-30 minutes	—

Processing Sequence B:

Operation:	Time of Treatment:	Temperature:
Agfacolor Paper Developer	3-6 minutes	18° C. (64° F.)
First wash (thorough)	5 minutes	—
Agfacolor Bleaching-Fixing Bath for Positive Film and Paper	8-15 minutes	16-20° C. (60-68°F.)
Second wash	10 minutes	—

At this step, filter tests may (after 10 minutes the paper may be exposed to daylight) be judged. If final prints are to be made, a

Total wash of	20 minutes	is given followed by:
Agfacolor Paper Hardening Bath		
Third wash	5 „	
Agfacolor Antifading Bath	5 „	
Drying	5 „	

* The development time may be varied slightly to give image contrast required.

Reversal Film

5. Numbers of films and papers treated by one litre (35 fl. oz.) of each solution.

(A) Agfacolor Reversal film

	Miniature Cassettes	Karat	Rollfilms B 2 / 8	Cut film 9 x 12 cm
First developer for Agfacolor Reversal Film	4	8	4	14
Color developer for Agfacolor Reversal Film	7	14	7	25
Bleaching Bath for Agfacolor Reversal Film	7	14	7	25
Fixing Bath for Agfacolor Reversal Film	7	14	7	25
Hardening Bath for Agfacolor Reversal Film	10	20	10	40

(B) Agfacolor Negative film

Negative Film

	Miniature film cartridges (36 exposures)	Karat cartridges	Rollfilm B/2-8	Flat film 9×12 cm (1/4 plate)
Agfacolor Developer for Negative and Positive Film	6	18	6	40
Agfacolor Bleaching Bath for Negative and Positive Film	10	25	10	24
Agfacolor Fixing Bath for Negative and Positive Film	6	18	6	24
Magnesiumsulphate Bath	6	18	6	24

(C) Agfacolor Positive film

Positive Film

Solution:	35-mm-film	6-cm-film (2 3/8" wide)	Flat films 9×12 cm (1/4 plate)
Agfacolor Developer for Negative and Positive Film	10 metres (11 yds.)	5 metres (5 1/2 yds.)	30 sheets
Agfacolor Positive Stop Bath	20 metres (22 yds.)	10 metres (11 yds.)	60 sheets
Agfacolor Bleaching-Fixing Bath for Positive Film and Paper	20 metres (22 yds.)	10 metres (11 yds.)	60 sheets
Agfacolor Special After Bath	20 metres (22 yds.)	20 metres (22 yds.)	60 sheets

(D) Agfacolor Paper

Agfacolor Paper

Solution:	Sheets 9×12 cm (1/4 plate) paper	Square metres of emulsion
Agfacolor Paper Developer	50	1/2
Agfacolor Paper Stop Bath	100	1
Agfacolor Paper Bleaching Bath	300-500	3-5
Agfacolor Paper Fixing Bath	300	3
Agfacolor Paper Bleaching-Fixing Bath	150	1,5
Hardening Bath for Agfacolor Paper	300	3
Agfacolor Antifading solution	150	1,5

6. Yield of Baths

	Agfacolor Reversal Film	Agfacolor Negative Film	Agfacolor Positive Film	Agfacolor Paper
First Developer for Reversal Film	+	−	−	−
Color Developer for Reversal Film	+	−	−	−
Bleaching Bath for Reversal Film	+	−	−	−
Fixing Bath for Reversal Film	+	−	−	−
Hardening Bath for Reversal Film	+	−	−	−
Color Developer for Negative/Positive Film	−	+	+	−
Bleaching Bath for Negative Film	−	+	−	−
Fixing Bath for Negative Film	−	+	−	−
Stop Bath for Positive Film	−	−	+	−
Bleaching/Fixing Bath for Positive Film and Paper	−	−	+	+
After Bath for Positive Film	−	−	+	−
Color Developer for Paper	−	−	−	+
Stop Bath for Paper	−	−	−	+
Bleaching Bath for Paper	−	−	−	+
Fixing Bath for Paper	−	−	−	+
Hardening Bath for Paper	−	−	−	+
Regenerator for Color Film Developer	−	+	+	−
Regenerator for Color Paper Developer	−	−	−	+
Regenerator for Bleaching/Fixing-Bath for Positive Film and Paper	−	−	+	+

Chemicals marked + a suitable for the respective materials and vice versal.

7. Arrangement of the three mosaic filters

Mosaic Filters

000000	200000	400000	600000	800000	990000
002000	202000	402000	602000	802000	992000
004000	204000	404000	604000	804000	994000
006000	206000	406000	606000	806000	996000
008000	208000	408000	608000	808000	998000
009900	209900	409900	609900	809900	999900

Y Yellow-Magenta

M

Yellow-Cyan Y

000000	200000	400000	600000	800000	990000
000020	200020	400020	600020	800020	990020
000040	200040	400040	600040	800040	990040
000060	200060	400060	600060	800060	990060
000080	200080	400080	600080	800080	990080
000099	200099	400099	600099	800099	990099

C

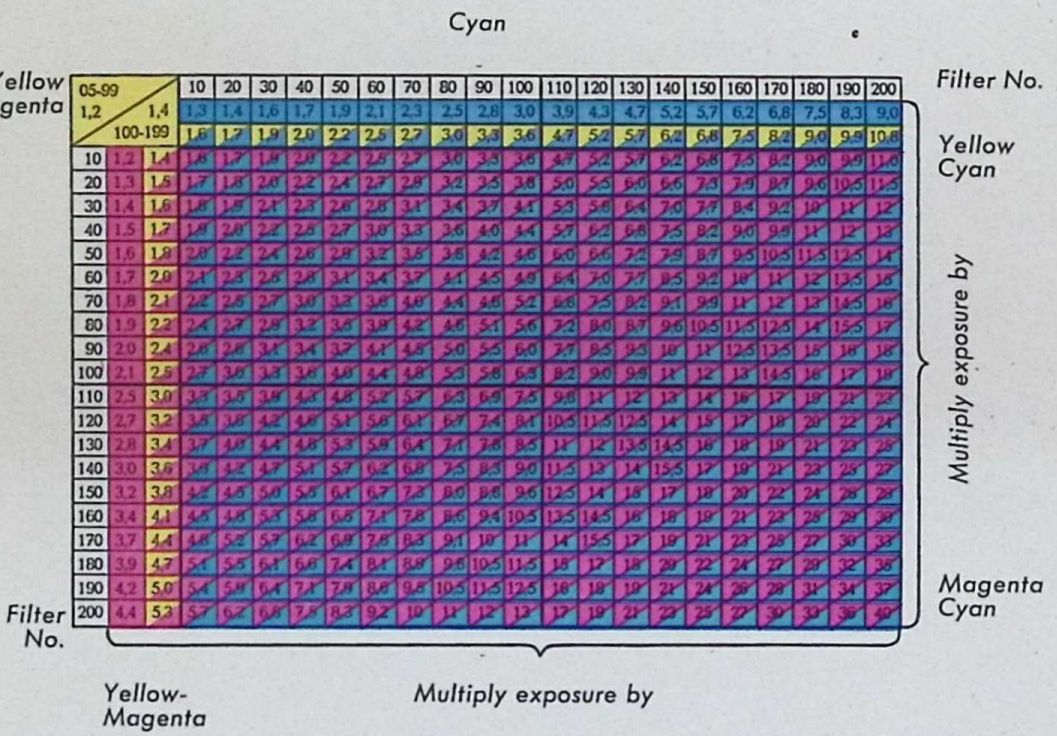
Magenta-Cyan M

000000	002000	004000	006000	008000	009900
000020	002020	004020	006020	008020	009920
000040	002040	004040	006040	008040	009940
000060	002060	004060	006060	008060	009960
000080	002080	004080	006080	008080	009980
000099	002099	004099	006099	008099	009999

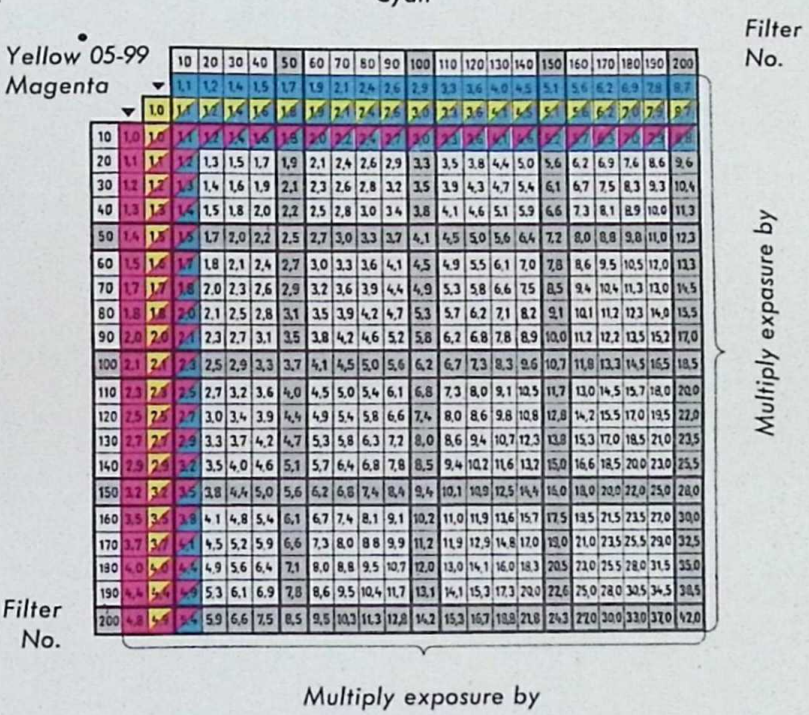
C

8. Exposure factors of Agfacolor Printing filters

A. Individual printing filters



B. Printing filters in the Agfacolor Varioscope with color attachment and for Agfa Seriograph with continuous filtering



	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
10	1,0	1,0	1,1	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2,0	2,1	2,2	2,3	2,4	2,5	2,6	2,7
20	1,1	1,1	1,2	1,3	1,5	1,7	1,9	2,1	2,4	2,6	2,9	3,3	3,5	3,8	4,4	5,0	5,6	6,2	6,9	7,6	8,6	9,6
30	1,2	1,2	1,3	1,4	1,6	1,9	2,1	2,3	2,6	2,8	3,2	3,5	3,9	4,3	4,7	5,4	6,1	6,7	7,5	8,3	9,3	10,4
40	1,3	1,3	1,4	1,5	1,8	2,0	2,2	2,5	2,8	3,0	3,4	3,8	4,1	4,6	5,1	5,9	6,6	7,3	8,1	8,9	10,0	11,3
50	1,4	1,5	1,5	1,7	2,0	2,2	2,5	2,7	3,0	3,3	3,7	4,1	4,5	5,0	5,6	6,4	7,2	8,0	8,8	9,8	11,0	12,3
60	1,5	1,6	1,7	1,8	2,1	2,4	2,7	3,0	3,3	3,6	4,1	4,5	4,9	5,5	6,1	7,0	7,8	8,6	9,5	10,5	12,0	13,3
70	1,7	1,7	1,8	2,0	2,3	2,6	2,9	3,2	3,6	3,9	4,4	4,9	5,3	5,8	6,6	7,5	8,5	9,4	10,4	11,3	13,0	14,5
80	1,8	1,8	2,0	2,1	2,5	2,8	3,1	3,5	3,9	4,2	4,7	5,3	5,7	6,2	7,1	8,2	9,1	10,1	11,2	12,3	14,0	15,5
90	2,0	2,0	2,1	2,3	2,7	3,1	3,5	3,8	4,2	4,6	5,2	5,8	6,2	6,8	7,8	8,9	10,0	11,2	12,2	13,5	15,2	17,0
100	2,1	2,1	2,3	2,5	2,9	3,3	3,7	4,1	4,5	5,0	5,6	6,2	6,7	7,3	8,3	9,6	10,7	11,8	13,3	14,5	16,5	18,5
110	2,3	2,3	2,5	2,7	3,2	3,6	4,0	4,5	5,0	5,4	6,1	6,8	7,3	8,0	9,1	10,5	11,7	13,0	14,5	15,7	18,0	20,0
120	2,5	2,5	2,7	3,0	3,4	3,9	4,4	4,9	5,4	5,8	6,6	7,4	8,0	8,6	9,8	10,8	12,8	14,2	15,5	17,0	19,5	22,0
130	2,7	2,7	2,9	3,3	3,7	4,2	4,7	5,3	5,8	6,3	7,2	8,0	8,6	9,4	10,7	12,3	13,8	15,3	17,0	18,5	21,0	23,5
140	2,9	2,9	3,2	3,5	4,0	4,6	5,1	5,7	6,4	6,8	7,8	8,5	9,4	10,2	11,6	13,7	15,0	16,6	18,5	20,0	23,0	25,5
150	3,2	3,2	3,5	3,8	4,4	5,0	5,6	6,2	6,8	7,4	8,4	9,4	10,1	10,9	12,5	14,4	16,0	18,0	20,0	22,0	25,0	28,0
160	3,5	3,5	3,8	4,1	4,8	5,4	6,1	6,7	7,4	8,1	9,1	10,2	11,0	11,9	13,6	15,7	17,5	19,5	21,5	23,5	27,0	30,0
170	3,7	3,7	4,1	4,5	5,2	5,9	6,6	7,3	8,0	8,8	9,9	11,2	11,9	12,9	14,8	17,0	19,0	21,0	23,5	25,5	29,0	32,5
180	4,0	4,0	4,4	4,9	5,6	6,4	7,1	8,0	8,8	9,5	10,7	12,0	13,0	14,1	16,0	18,3	20,5	23,0	25,5	28,0	31,5	35,0
190	4,4	4,4	4,9	5,3	6,1	6,9	7,8	8,6	9,5	10,4	11,7	13,1	14,1	15,3	17,3	20,0	22,6	25,0	28,0	30,5	34,5	38,5
200	4,8	4,8	5,4	5,9	6,6	7,5	8,5	9,5	10,3	11,3	12,8	14,2	15,3	16,7	18,8	21,8	24,3	27,0	30,0	33,0	37,0	42,0

7. Correcting baths for treating bad color reproduction in Agfacolor Reversal transparencies and Agfacolor Positive film transparencies

N. B. These baths are NOT suitable for treating Agfacolor Negative film or Agfacolor Paper prints

In using the correction baths, it must be noted that the treatment decreases the density of all the colors to some extent. Dense transparencies are thus better suited to correction than are thin ones. The time of treatment depends on the extent of the correction required.

a) Yellow cast

5 g of sodium cholate (supplied by Messrs. Böhringer, Ingelheim) and 15 g of sodium carbonate anh. are dissolved in 1 L of water. Duration of treatment 3—6 minutes, at 65—68°F. Action of the correcting bath on the film can be well observed and is carried to the desired degree.

b) Magenta cast

Solution I

30 g of meta-aminobenzoic acid hydrochloride (supplied by Agfa Leverkusen) are dissolved in 1 L of water.

Solution II

30 g of borax are dissolved in 1 L of water.

The pictures turn purple in solution I. At 65—68°F. the pictures remain in the solution from 4—10 minutes according to the desired degree of magenta reduction. The action cannot be observed in this case and must be determined by trial and error. After a short intermediate rinse the pictures are introduced into solution II, where they remain 3—5 minutes. The colors are restored in this solution except magenta which is held back according to the degree of activity of solution I.

c) Cyan cast

8 g of acetanilide (supplied by Agfa Leverkusen) and 4 g of sodium carbonate anh. are dissolved in 1 L of water. Immersion time 2—4 minutes at 65—68°F. The color change can be observed in the correcting bath and should be stopped in time as it continues into the final rinse.

d) Blue cast

2 g of sodium peroxide (obtainable from any chemist), 1 L of water, treat 1—4 minutes, wash 20 minutes."

If the films to be corrected are immersed in a dry state, the correcting baths will act more rapidly than the on pre-soaked films.

After their treatment in the correcting baths, films should be washed for 20 minutes and dried. Color reduction carried too far cannot be reversed. Insufficient color reduction may be repeated.

A general reduction of excessively dense transparencies is possible by passing them through several correcting baths successively.

The choice of immersion time in the correcting baths depends on the color cast of the transparency.

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